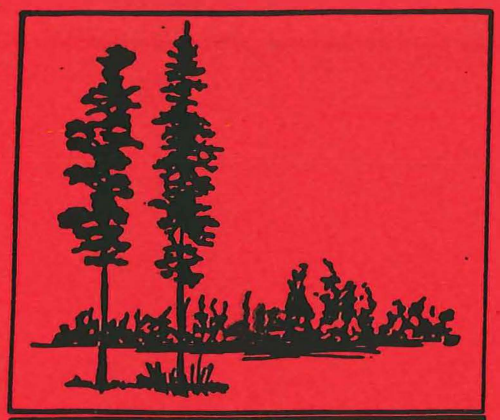

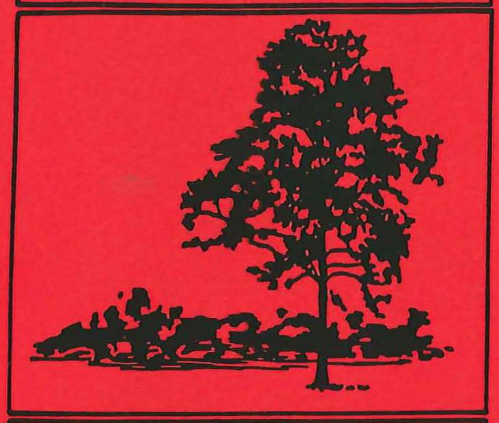

FOREST PEST CONDITIONS IN WISCONSIN

ANNUAL REPORT

1996

DEPARTMENT OF NATURAL RESOURCES
BOX 7921
MADISON, WISCONSIN 53707

FOREST PEST CONDITIONS IN WISCONSIN
ANNUAL REPORT - 1996

Edited by
Jane Cummings Carlson, Dave Hall,
and Al Prey

DEPARTMENT OF NATURAL RESOURCES
Division of Resource Management
Bureau of Forestry

ACKNOWLEDGMENTS

This record of activities of forest pests and other destructive agents of growing trees in Wisconsin's forest nurseries, plantations, and natural timber areas was made possible by the dedicated work of pest management personnel in each district and at the Forest Pest Management Laboratory in Madison. Department of Natural Resources foresters, other department field personnel, cooperators in other public agencies and private forest industry contributed valuable assistance in monitoring the forest lands in all classes of forest ownership.

Preparation of this Annual Report was a result of a team effort involving Andrea Diss, Todd Lanigan, and Shane Weber, DNR Regional Pest Specialists and Lyle Buss, Intern, each of whom submitted reports. Jane Cummings Carlson and Dave Hall, Forest Pest Program, Madison, consolidated the district reports and wrote the draft, and Stephanie Sieger compiled the final report. Printing was done by the DOA Copy Shop.

Allen J. Prey
Coordinator, Forest Pest Management

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INTRODUCTION

In 1996, insect and disease detection surveys were conducted on 13 million acres and evaluation surveys on 4.9 million acres. In addition, Wisconsin DNR district pest specialists continued to teach integrated pest management principles to Wisconsin DNR foresters, industrial foresters, and private woodland owners. District forest pest specialists and forest pest unit staff provided a wide variety of programs and information on forest pests in 1996. Approximately 5425 individuals were educated at 98 different training sessions.

OUTREACH

Presentations on IPM practices and updates on specific pest problems were given to the following groups and meetings: Wisconsin Woodland Owners Association; The Governor's Council on Forestry; UW Stevens Point students; UW LaCrosse students; UW Extension Master Gardeners; Midwest Forest Stewardship Conference; Walnut Council; Wisconsin Arborists Association; Forest Productivity Council; Wisconsin Christmas Tree Producers Association; Western WI Board of Realtors Inc. & St. Croix Valley Home Builders Assoc.; Bureau of Forestry staff; DNR; Elementary schools (including gypsy moth in-class projects and games; Forest Pest Advisory & Steering Council; Wisconsin Electric Power Co.; officials and the general public in Brown, Dane, Door, Eau Claire, Oconto, and Marinette counties (gypsy moth); Kiwanis club, 4-H, and youth Summer Education Programs.

Numerous radio and TV interviews and press releases were conducted on topics including gypsy moth biology, trapping and management; oak wilt biology and management; oak leaf tatters, ticks; jack pine budworm; and mosquitoes.

Presentations were made at the following professional meetings: American Phytopathological Society annual meeting; International Tree Seed Pathology meeting at Opocno, Czech Republic; Audubon Society meeting; North Central Forest Pest Workshop; Wisconsin Arborists Association statewide meeting; and Wisconsin Society of American Foresters chapter and statewide meetings.

The forest management exhibit showcasing the gypsy moth, oak wilt, walnut freeze injury and other pests was displayed at meetings of the following associations; Wisconsin Woodland Owners; Wisconsin Christmas tree growers; and various DNR district and area meetings and county fairs.

TRAINING

Foresters, Christmas tree growers and woodland owners were trained on various topics including: identification and management of needlecast diseases; gypsy moth biology and silviculture; oak wilt biology and management; Karner blue butterfly; vegetation management; jack pine budworm; birch leaf miner; and hickory bark beetle.

Some or all of the forest pest specialists and forest pest staff attended numerous training sessions including: forest vegetation management; DNR computer training courses; Prepare to Meet the Press training and the North Central Forest Pest Workshop.

MEETINGS

Some or all of the forest pest specialists and forest pest staff attended the following meetings: USDA Forest Service state cooperators meeting; North Central Forest Pest Workshop; American Phytopathological Society annual meeting; Forest Health Monitoring planning sessions; Wisconsin Christmas Tree Growers Association meetings; Gypsy Moth National Review Meeting; Gypsy Moth Slow the Spread meeting and North American Maple Project Review.

REPORTS, PAPERS, AND PROJECTS

The following reports were completed: forest pest situation; accomplishment report and the annual report of forest pest conditions. Information sheets were written on herbicides for forestry; gypsy moth silviculture for northern hardwoods and gypsy moth implementation plan. Initiated a forest pest distribution GIS project on the Northern highland American Legion State Forest. Organized a team of Forest Service and University researchers to develop a biological control technique for chestnut blight. Continued a project with the Bureau of Endangered Resources and woodland owners to initiate a butternut recovery program.

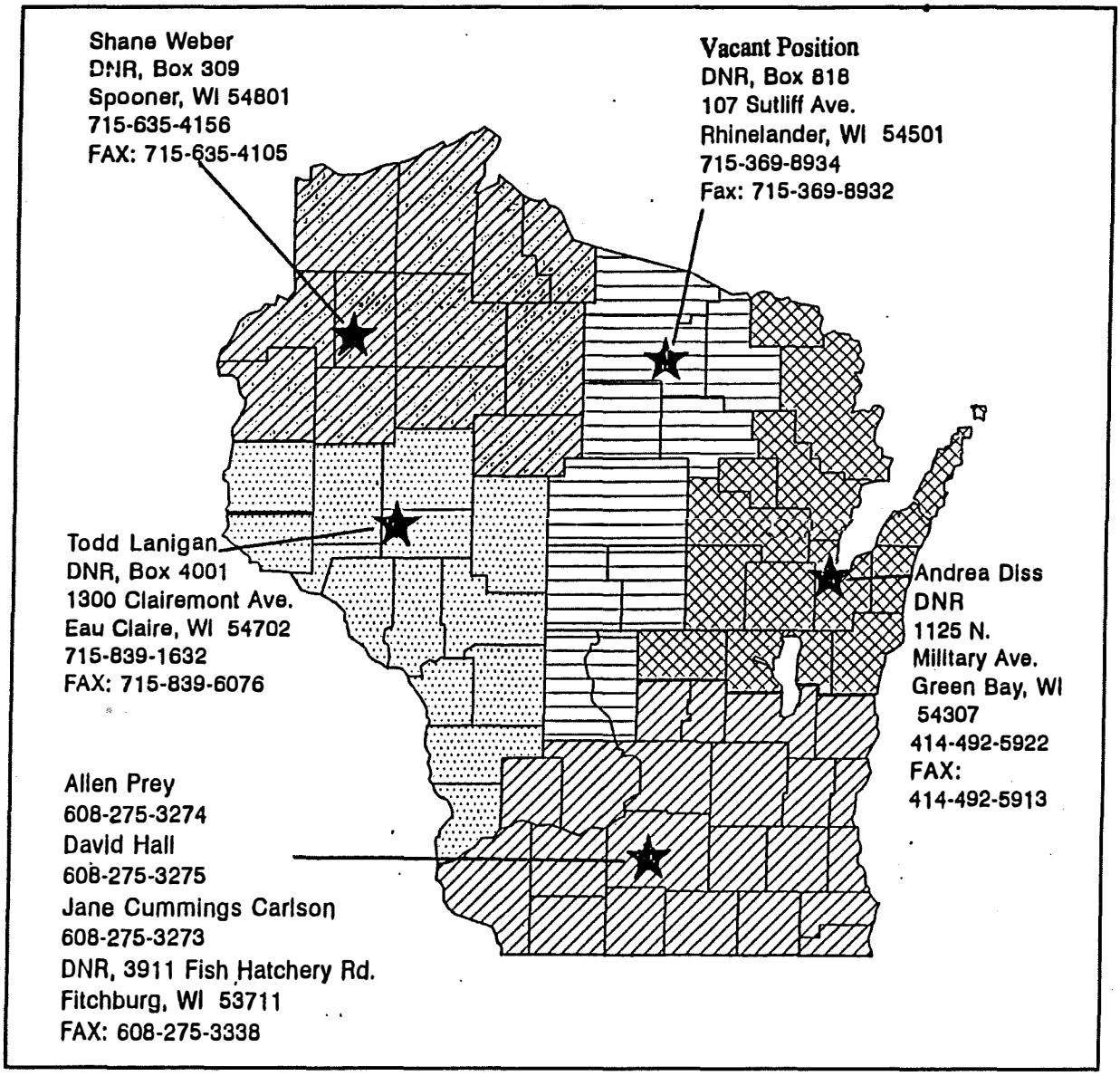
Published a B.t.k. article on killing caterpillars for WI Woodland Management Magazine; Pest Management Guidelines for white pine, red pine, and jack pine were revised for inclusion in the DNR Silviculture and aesthetics handbook. Co-authored a leaflet called "How to Identify and Manage Needlecast Diseases on Balsam Fir."

DEPARTMENT OF NATURAL RESOURCES
Forest Pest Management Personnel - 1996

Name	Title	Address	Phone /Email
Prey, Allen J.	Supervisor, Forest Pest Management	DNR, 3911 Fish Hatchery Road, Madison, WI 53711	(608) 275-3274 preya@dnr.state.wi.us
Cummings Carlson, Jane E.	Forest Pathologist	DNR, 3911 Fish Hatchery Road, Madison, WI 53711	(608) 275-3273 cummij@dnr.state.wi.us
Hall, David J.	Forest Entomologist	DNR, 3911 Fish Hatchery Road, Madison, WI 53711	(608) 275-3275 halld@dnr.state.wi.us

****

Diss, Andrea	Forest Entomologist	DNR, LMD Headquarters 1125 N. Military Avenue P. O. Box 10448 Green Bay, WI 54307	(414) 492-5922 dissa@dnr.state.wi.us
Vacant	Forest Pest Specialist	DNR, NCD Headquarters 107 Sutliff Avenue P. O. Box 818 Rhinelander, WI 54501-0818	(715) 365-8934
Lanigan, Todd	Forest Pest Specialist	DNR, WD Headquarters 1300 W. Clairemont Ave. P. O. Box 4001 Eau Claire, WI 54702-4001	(715) 839-1632 lanigt@dnr.state.wi.us
Weber, Shane D.	Forest Entomologist	DNR, NWD Headquarters Hwy. 70 West P. O. Box 309 Spooner, WI 54801-0309	(715) 635-4156



Station locations of Wisconsin Department of Natural Resources District Entomologists and Forest Pest Unit Personnel, December 31, 1996.

FOREST PEST CONDITIONS IN WISCONSIN
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ARBORVITAE

Severe winterkill was apparent across the northern region of the state. In some places cambial injury was followed by fatal attacks of northern cedar bark beetles (*Phloeosinus canadensis*).

ASH

Ash Plant Bug - *Tropidosteptes amoenus* Reuter

The ash plant bug caused premature leaf drop on the lower branches of yard trees in LaCrosse and St. Croix counties.

Across northwestern Wisconsin, moderate populations caused stippling, marginal scorch, and occasionally leaf drop.

Black Ash Dieback

Black ash in parts of Forest and Oneida counties had significant branch dieback, often with the entire crown dead. Epicormic sprouting on these trees was also common. Wet, poorly drained sites along with late spring frosts and the high water table in 1993 probably contributed to the problem.

Mountain-ash Sawfly - *Pristiphora geniculata* (Hartig)

Very light defoliation on yard trees in Eau Claire County.

Always common on yard ash in the northwest, this pest was less numerous and caused less damage than in the past several years.

Colonies were feeding on a dozen mountain-ash at a cemetery in Langlade County, north of Antigo. Defoliation was noticeable but light.

ASPEN

Large Aspen Tortrix - *Choristoneura conflictana* (Walker)

A 10-15 acre stand of trembling aspen suffered moderate defoliation by aspen tortrix in Marinette County.

Cytospora Canker

One clone in a plantation of hybrid poplar was severely damaged in Shawano County. Other clones at the same plantation had little or no damage.

Aspen Blotch Miner - *Phyllonorycter tremuloidiella* (Braun)

Populations were down this year in northwestern Wisconsin. Only occasional browning on a few roadside poplars was observed.

Wind Damage

Three to four acres of quaking and bigtooth aspen were blown down in Mead State Wildlife Area, Marathon County, during a storm in early summer.

BALSAM FIR

Spruce Budworm - *Choristoneura fumiferana* (Clemens)

Overall, spruce budworm populations were low in northwestern Wisconsin. There was a small amount of light defoliation in Ashland County, and some moderate to heavy damage in a white spruce plantation in the town of Stinnett, Washburn County. Adjacent wild balsam fir was virtually untouched.

A 40 acre stand of 20 year old balsam fir in Marinette County was moderately defoliated by spruce budworm. Two other small stands of mixed balsam fir and spruce nearby were also lightly to moderately damaged.

Balsam Gall Midge - *Paradiplosis tumifex* (Gagne)

The gall midge was present in northern Wisconsin, but at inconspicuous levels only.

Balsam Twig Aphid - *Mindarus abietinus* (Koch)

Widespread light to moderate damage occurred in Washburn and Sawyer counties.

Balsam Fir Needlecast and Blight - *Lirula nervata* (Dark.) Dark., *L. mirabilis* (Dark.) Dark., *Rhizosphaera pini* (Cda.) Maubl.

These fungi were common on lower crowns of balsam fir in Ashland, Bayfield, Iron, Price, and Sawyer counties.

BASSWOOD

Complex of Late Season Defoliators

Orange humped mapleworm, variable oakleaf caterpillar, maple webworm, maple trumpet skeletonizer and American daggermoth together caused moderate to severe defoliation of basswood, beech, hop hornbeam, and maple in September in woodlots at the tip of the Door Peninsula, Washington and Rock Islands.

Linden Looper - *Erannis tiliaria* (Harris)

The looper complex produced noticeable defoliation on basswood in central Polk County.

Defoliation by linden looper was less intense this year on Rock Island with basswood and sugar maple suffering light to moderate damage.

Introduced Basswood Thrips - *Thrips calcaratus* (Uzel)

Thrips caused light to severe defoliation wherever basswood occurred in Florence, Marinette, Menominee, and Oconto counties.

Light to moderate defoliation occurred on basswood in Chippewa, Dunn, Peppin and Sheboygan counties.

In north central Wisconsin, introduced basswood thrips caused light to severe defoliation in Forest, Langlade, Lincoln, and Oneida counties (Figures 1-4). Defoliation totaled 182, 400 acres in the four counties (Table 1). The infestation was the worst near Crandon, Forest County (Figure 1), where basswood is a major component of the overstory. Trees with heavy defoliation refoliated in July.

Table 1. Defoliation by introduced basswood thrips, North Central District 1996.

County	Defoliation (Acres) Light to Moderate	Moderate to Severe	Total
Forest	0	21,760	**21,760**
Langlade	58,240	44,800	**103,040**
Lincoln	13,440	3,200	**16,640**
Oneida	26,240	14,720	**40,960**
Total	**97,920**	**84,480**	**182,400**

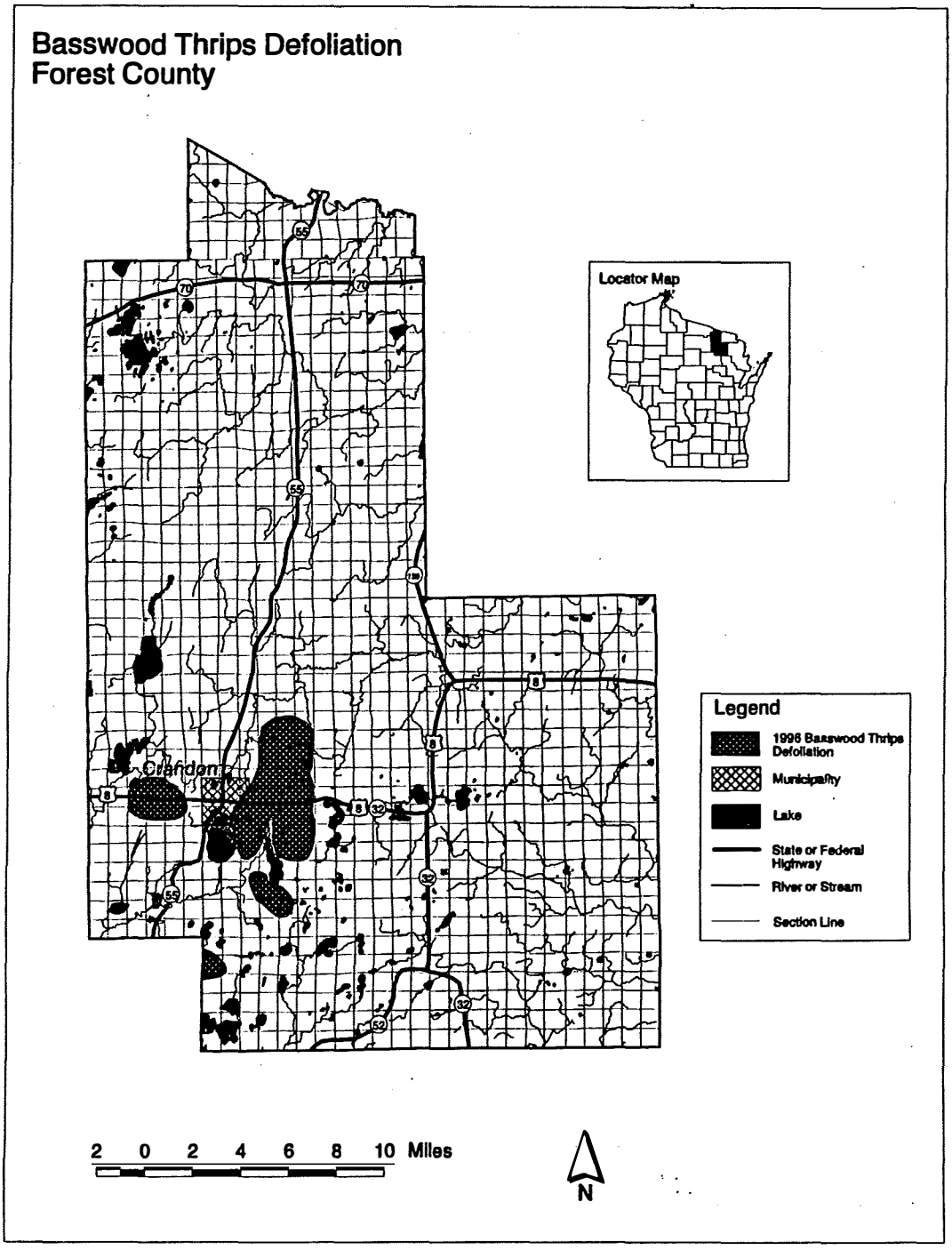

Figure 1. Basswood thrips defoliation, Forest County, 1996.

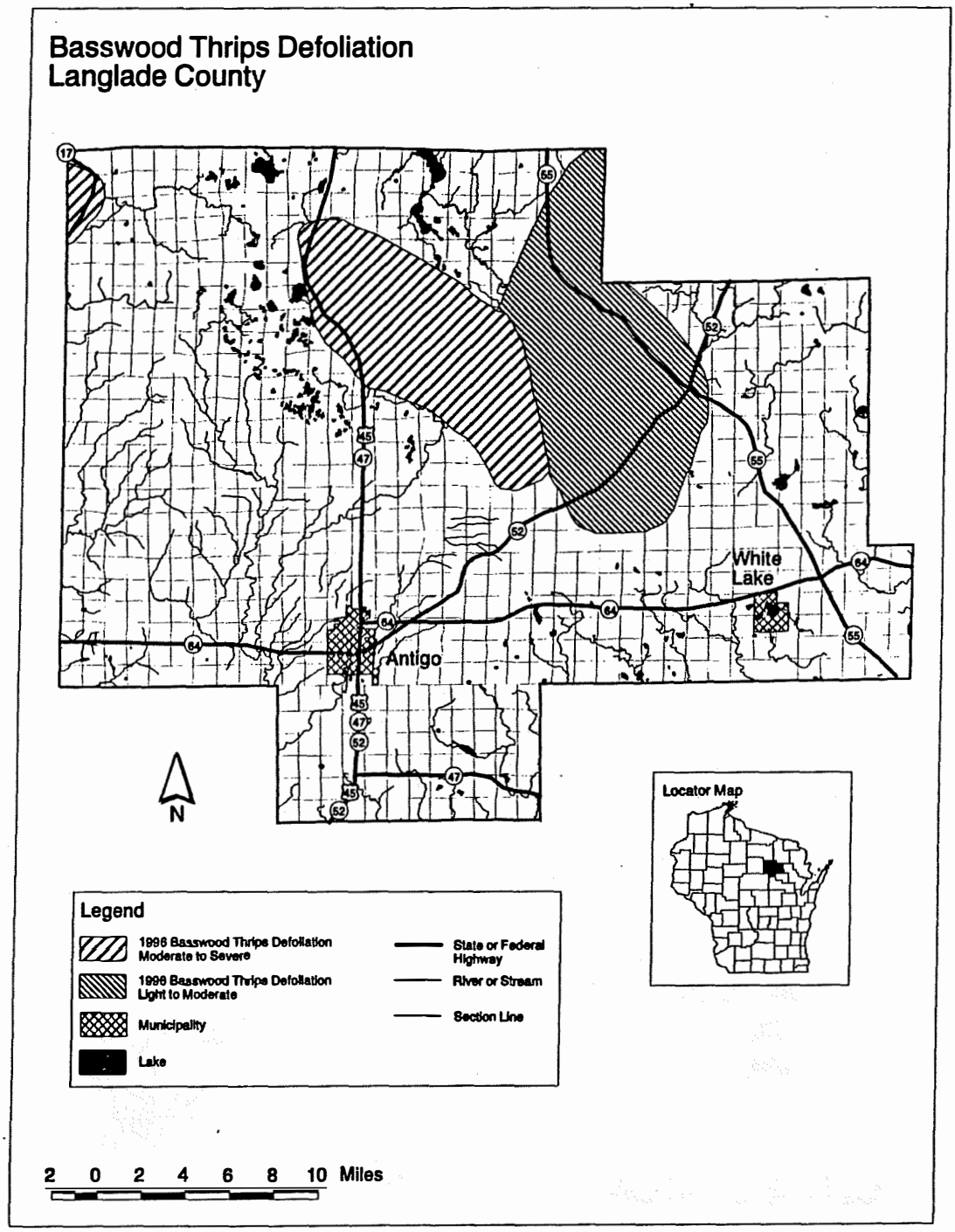

Figure 2. Basswood thrips defoliation, Langlade County, 1996.

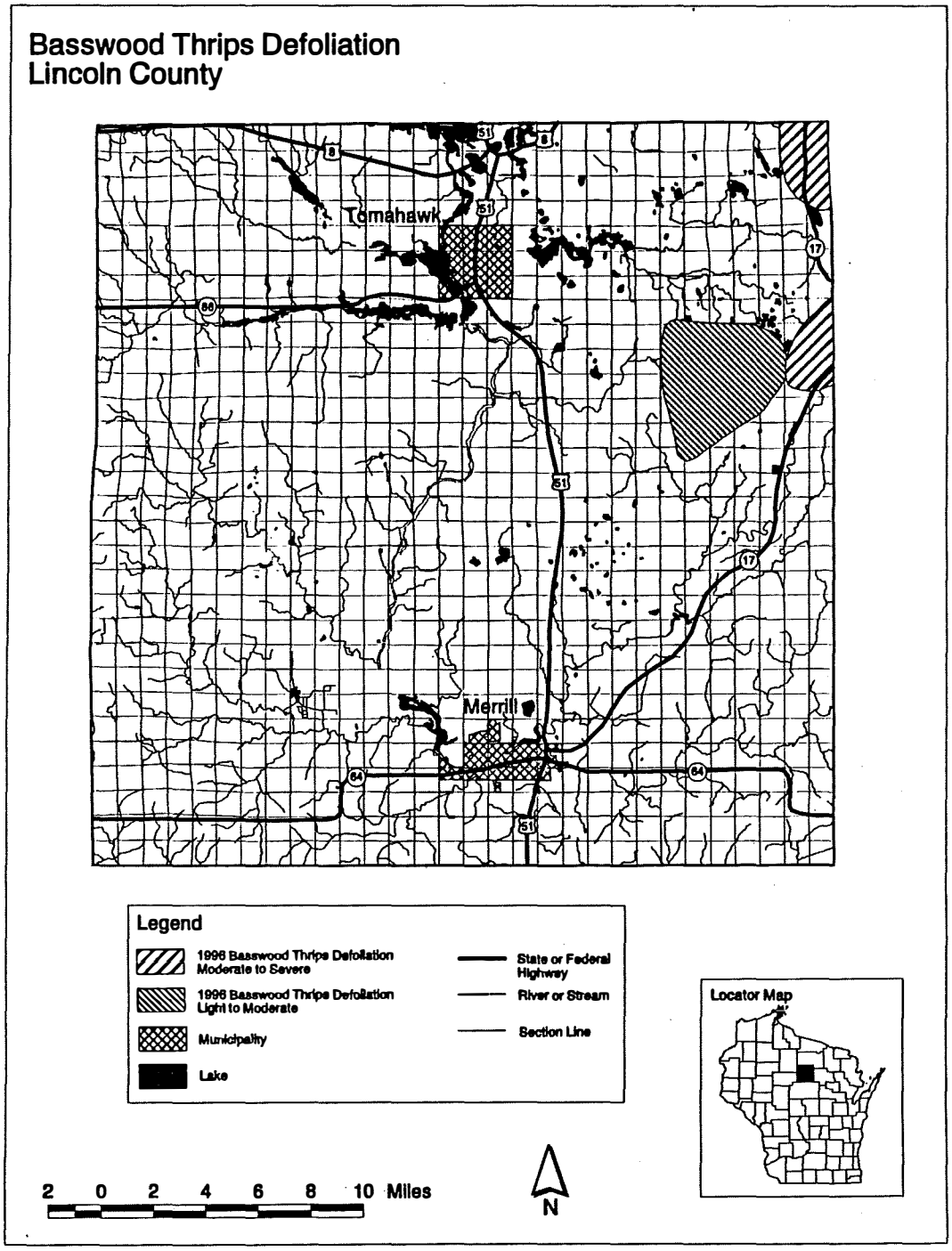

Figure 3. Basswood thrips defoliation, Lincoln County, 1996.

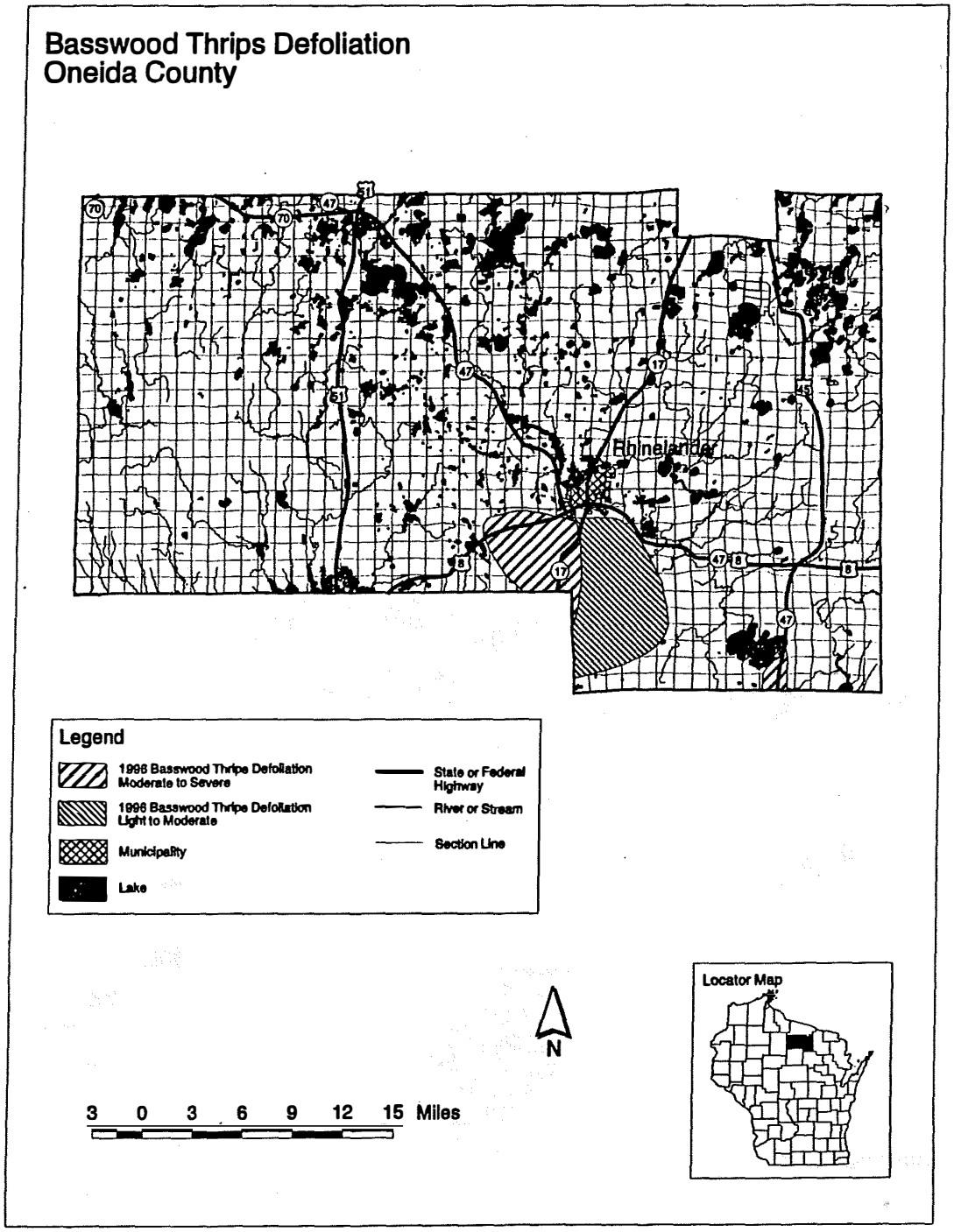

Figure 4. Basswood thrips defoliation, Oneida County, 1996.

Pockets of basswood totaling 8,500 acres suffered moderate to heavy defoliation in Rusk and Sawyer counties (Figures 5-6) . Defoliation occurred in scattered pockets wherever basswood grew in northwestern Wisconsin, except for McKinley township of Polk County.

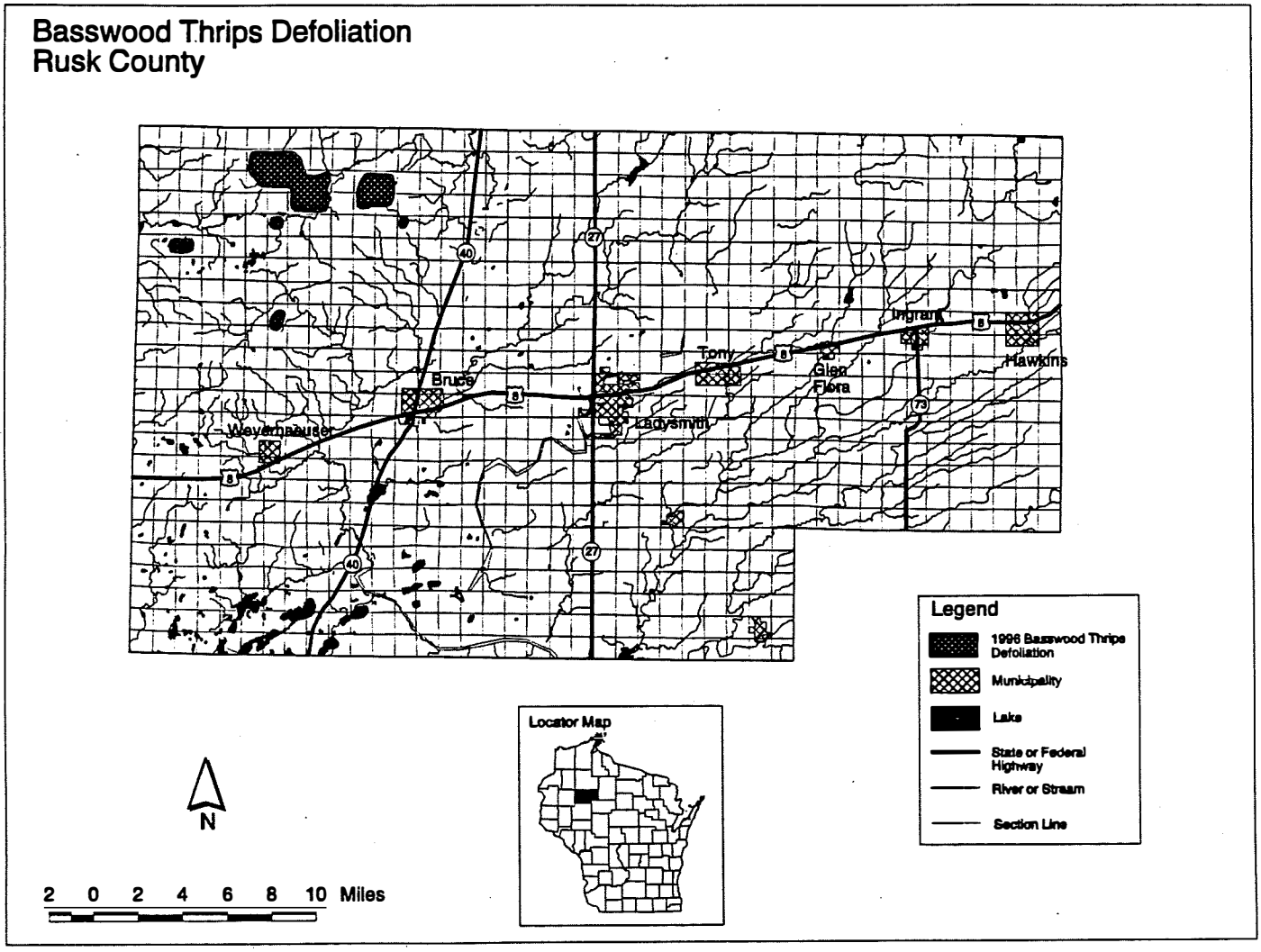

Figure 5. Basswood thrips defoliation, Rusk County, 1996.

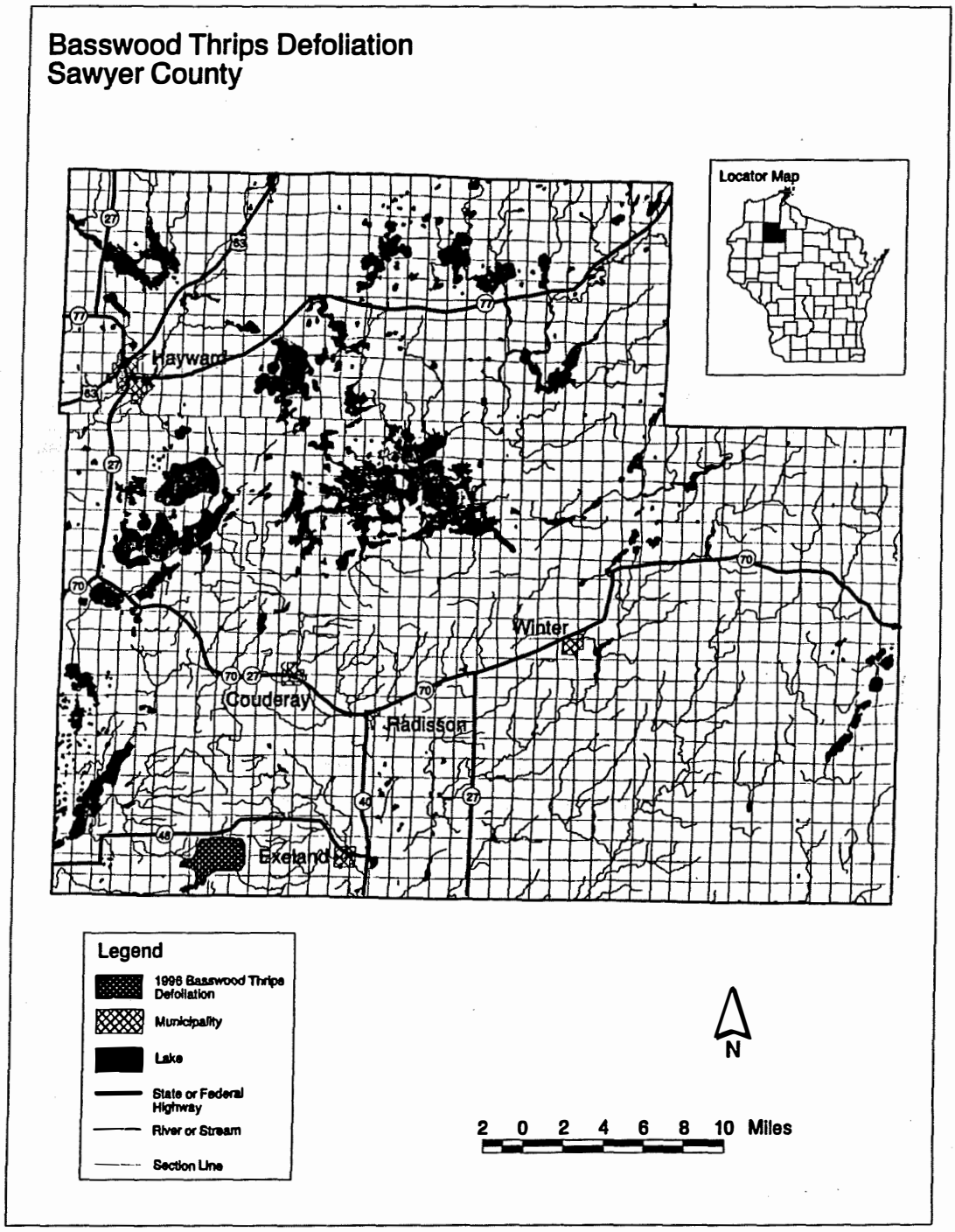

Figure 6. Basswood thrips defoliation, Sawyer County, 1996.

BEECH

Variable oakleaf caterpillar defoliated beech in Newport State Park, Washington and Rock Islands in late September.

BIRCH

Birch Leafminer - *Fenusa pusilla* (Lepeletier)

A small stand of white birch in Buffalo County was heavily hit by sawflies.

Northwestern Wisconsin experienced the usual brownout of scattered roadside and ornamental birch trees. Leafminer was more prevalent in Burnett and Washburn counties than in places north and east.

BLACK LOCUST

A Sawfly - *Nematus* sp. (Lepeletier)

A rare occurrence of heavy defoliation of mature, ornamental black locust occurred in Sauk County. Heavy defoliation of mature black locust shade trees was reported in Baraboo, Sauk County.

BLACK WALNUT

Walnut Caterpillar - *Datana integerrima* Grote & Robinson

Increasing populations caused defoliation to individual black walnut trees in Dane County.

Cold Injury

In February, 1996, extremely cold temperatures (-40 to -50° F) were recorded throughout Wisconsin. Temperatures below -40° F have caused injury to black walnut in past years. The most common symptoms of cold injury include small to large spots of dead cambium which appear as black areas on otherwise white tissue. The dead cambium can be observed by stripping the bark from affected trees. As the growing season progresses, affected trees will either fail to leaf out, produce a sparse crown, or produce sprouts on the main stem only. Most affected trees will die within the first growing season.

Injury was most prevalent in Richland County, southwestern Wisconsin. Affected trees were limited to areas where cold air drains or is trapped (valley-bottoms). In January, 1994, similar weather conditions caused widespread mortality of black walnut in valley-bottoms; thus many of the areas affected by the 1996 cold injury had already suffered high levels of mortality in 1994 (see 1994 Forest Pest Conditions in WI Annual Report).

BUTTERNUT

Butternut Canker - *Sirococcus clavigignenti - juglandacearum* (Nair, Kostichka and Kuntz)

Butternut canker has been observed in 48 of the 62 counties where butternut is known to occur (Figure 7). Activities on this disease continue to focus on determining silvicultural methods that minimize the impact of butternut canker and maximize the potential for regeneration of this species. A study on the Menominee Indian Reservation was initiated in 1994 to address these questions (see 1995 Forest Pest Conditions in WI Annual Report).

Wisconsin DNR is also cooperating with the USDA Forest Service to locate potentially disease resistant trees. These trees serve as a source of scion wood (twigs that are grafted onto walnut or butternut root stock). These grafted clonal lines are maintained in plantings in an effort to 1) preserve potentially resistant material, 2) test for true disease resistance and 3) provide a setting where controlled pollination efforts can produce seed that carries a high potential for disease resistance.

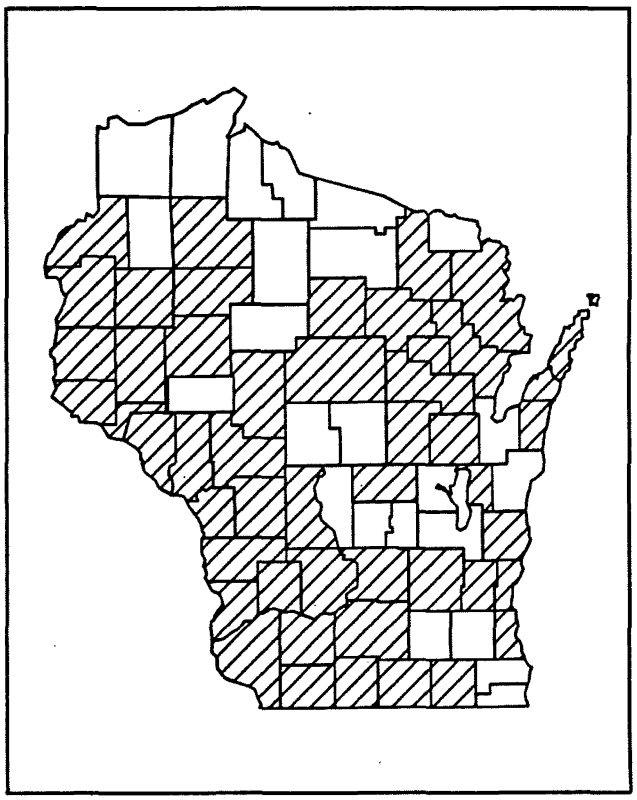

Figure 7. Know county locations of butternut canker in Wisconsin, 1996.

Information has been passed on to landowners (through publications and presentations at landowner conference) on the following 3 topics: 1) regenerating butternut in woodlands where it is already present, 2) encouraging collection of seed for state and private nurseries and 3) planting butternut seedlings or seeds.

CHERRY

Eastern Tent Caterpillar - *Malacosoma americanum* (Fabricius)

Tents were still quite common across northwestern Wisconsin, but not as prevalent as in the past two years.

In western Wisconsin, a small amount of tents were observed; those that were found were small.

Cherry Scallop Shell Moth: *Hydria prunivorata* Ferguson

Black cherry were lightly to heavily defoliated in Columbia, Marquette, and northern Sauk counties. In some areas only understory trees were defoliated.

There were reports of large numbers of moths in and around homes in Eau Claire County. Feeding damage was evident on wild cherry in Dunn, Eau Claire, Monroe, and Wood counties. Damaged trees looked like they were on fire.

Black cherry in Adams, Juneau, Marathon, and Portage counties suffered low to total defoliation due to this insect. This was the second consecutive year of defoliation for many of the trees. Damaged cherry in Portage County refoliated by mid August.

Uglynest Caterpillar - *Archips cerasivorana* (Fitch)

The uglynest caterpillar was still present but at lower population levels in Burnett and Polk counties.

AMERICAN CHESTNUT

Chestnut Blight - *Cryphonectria parasitica* (Murr.) Barr

One new location of chestnut blight was documented in 1996; Richland County, southwestern Wisconsin, T11N, R2E, SESE, Sec. 31 (Figure 8).

Efforts continued in 1996, to introduce a biological control agent (a hypovirus) into a stand of American chestnut in LaCrosse County. This is a cooperative project between scientists at West Virginia University, Michigan State University and Cornell University; funded in part by the grant from the USDA Forest Service and the American Chestnut Foundation. Inoculations of a European hypovirus were conducted for the second year in a row, on American chestnuts infected with the fungus causing chestnut blight, *Cryphonectria parasitica*. Prior to these inoculations, a hypovirus from Michigan was used as a biological control agent for 3 years.

Annual surveys were conducted to determine the number of newly infected trees and the level of crown dieback of infected trees (Figures 9 and 10). Thirty-two newly infected trees were observed in 1996. Laboratory analysis revealed some of the new cankers were already hypovirulent (contained the hypovirus), thus the biological control agent appears to be moving through the stand. Higher levels of crown dieback was more frequently observed in the stand. Extremely cold temperatures recorded in February are likely to have contributed to the dieback.

The locations of infected trees, forest roads and property boundaries were recorded with a geographic positioning system for mapping purposes. The map will be used to help plan inoculation efforts in 1996 and graphically display the spread of *C. parasitica* and the hypovirus. A survey to determine the extent of disease spread is planned for April, 1996. Inoculations of infected trees with the European hypovirus are planned for late May, 1996.

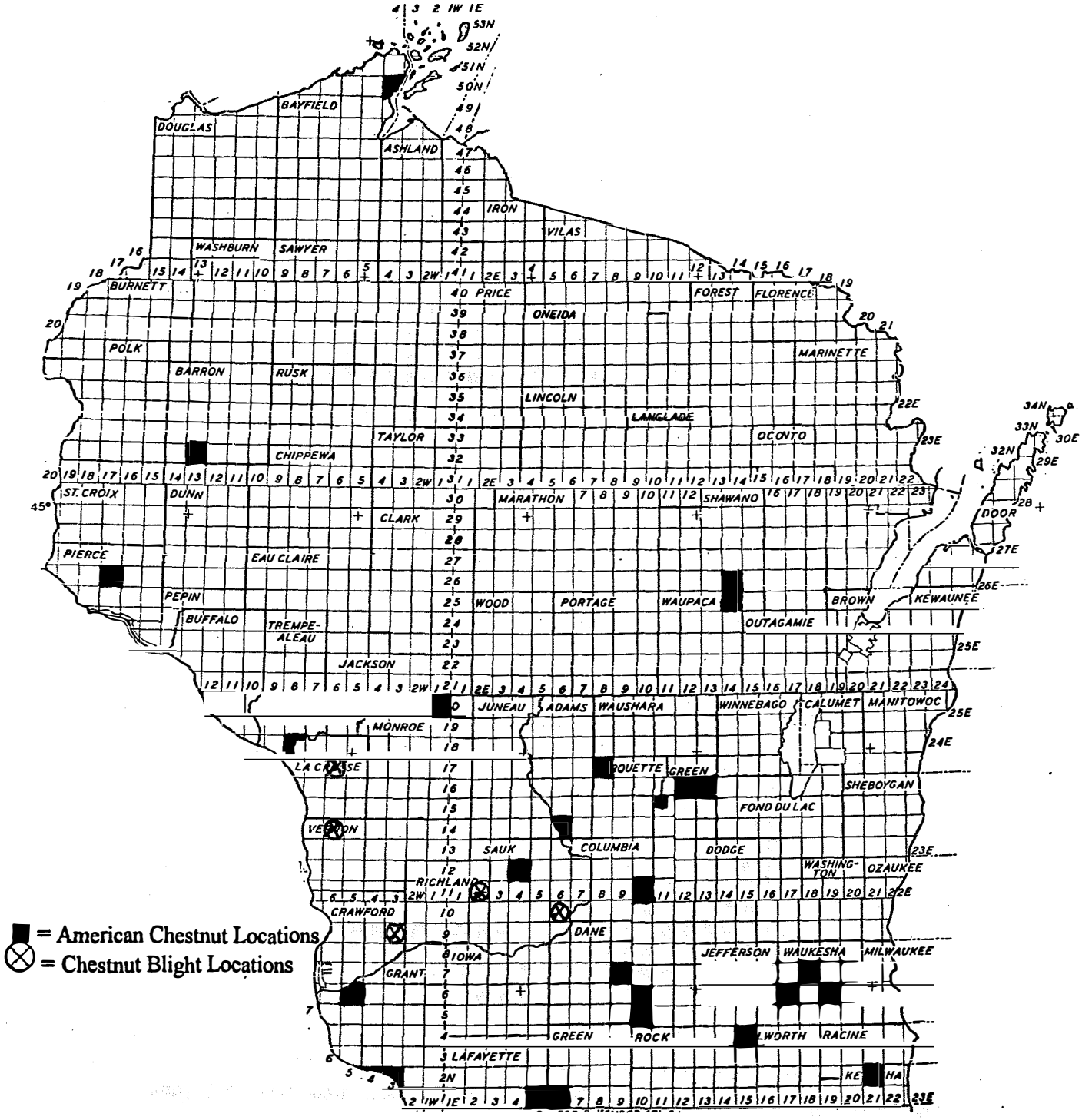

Figure 8. Township locations of American chestnut and chestnut blight in Wisconsin, 1996.

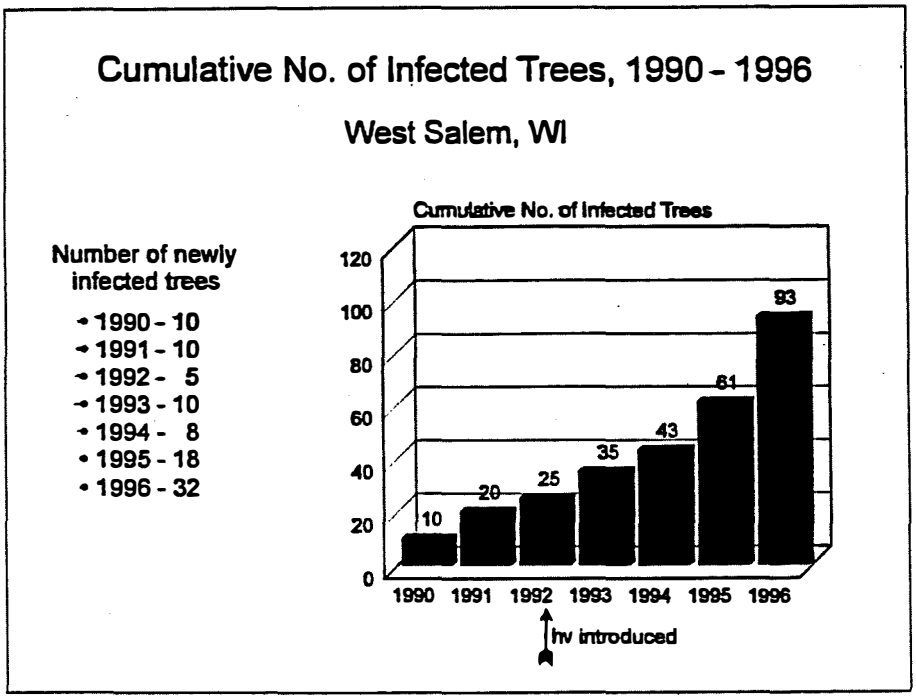

Figure 9. Number of newly infected American chestnut, West Salem, WI, 1996.

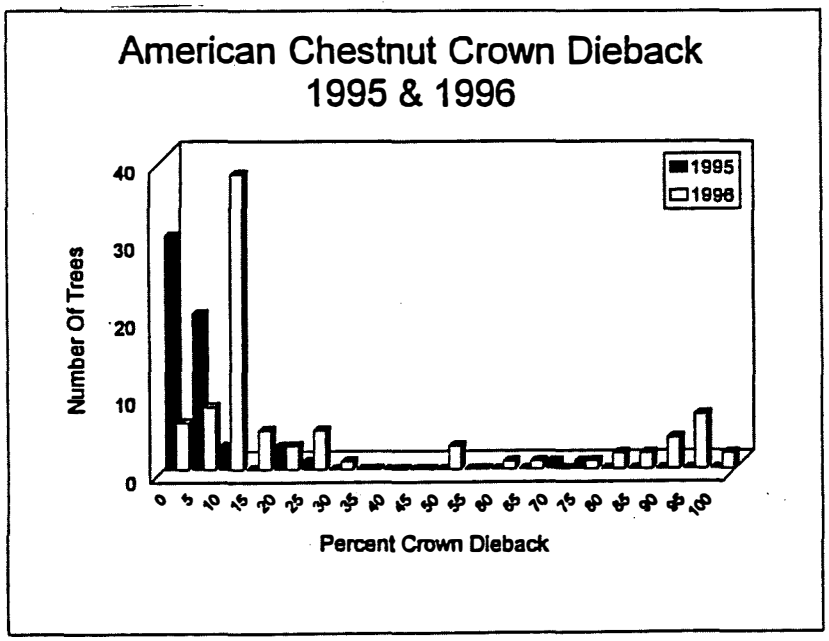

Figure 10. Level of crown dieback of infected American chestnut, West Salem, WI, 1996.

CHRISTMAS TREES

Zimmerman Pine Moth - *Dioryctria zimmermani* (Grote)

Christmas tree growers reported an increase in damage from this pest on scotch and white pines this summer.

Scattered flagging and dead branches were present in Scotch pine plantations in Chippewa and Jackson counties. The Zimmerman population was high in Jackson County, and caused a lot of damage.

White Pine Tip Weevil - *Pissodes strobi* (Peck)

Weevils damaged terminals of blue spruce, scotch and white pines in Waushara County.

Eastern Gall Rust - *Cronartium quercuum* (Berk.) Miyabe ex Shirai

Scattered flagging, as well as dead branches were observed in Scotch pine plantation in Chippewa and Jackson counties.

Sphaeropsis Shoot Blight - *Sphaeropsis sapinea* (Fr.:Fr.) Dyko & Sutton in Sutton

In Jackson County, dead shoots were present in a Scotch pine plantation. Some trees were heavily infested in pockets, others were scattered throughout the plantation.

Cyclaneusma Needlecast - *Cyclaneusma minus* (Butin) DiCosmo, Peredo & Minter

Two plantations were infected with Cyclaneusma, one in Chippewa County, the other in Jackson County. In both plantations, some trees were so heavily infected that the only remaining needles were at the tips of branches. Trees adjacent to the heavily infected ones did not look bad, while other trees were just beginning to lose their needles.

Balsam Fir - Necrosis of shoots

In a plantation in Jackson County, balsam fir were turning yellow and new shoots were browning, curling and dying. This is possibly due to the hot summer in 1995 and the cold winter in 1995-96, or due to nutrient deficiency as trees were planted in sandy soils.

Lirula Needlecast - *Lirula nervata* (Dark.) Dark., *L. mirabilis* (Dark.) Dark.

See Appendix A for report on *Lirula nervata and L. mirabilis*.

Rhizosphaera Needlecast - *Rhizosphaera pini* (Cda.) Maubl.

Rhizosphaera was confirmed on balsam fir in a plantation in Pierce County. Scattered trees had a few browning branches near the bole.

Balsam Twig Aphid - *Mindarus abietinus* Koch

A 3.5 acre balsam fir Christmas tree farm in Oneida County had aphid problems. Not all trees were affected, but selected trees had severe infestations and were rendered unmarketable.

Balsam Gall Midge - *Paradiplosis tumifex* Gagne

The gall midge population was up this year in western Wisconsin. Christmas tree growers were concerned about receiving balsam roping with galls present on the needles; they did not want to introduce the gall midge into their plantations.

Pine Spittlebug - *Aphrophora parallela* (Say)

Large numbers of adult spittlebugs and a few nymphs were present on the main stem of Scotch pine in Jackson County. There was some shoot mortality due to spittlebug feeding.

Pales Weevil - *Hylobius pales* (Herbst)

Last fall's feeding damage by pales weevil showed up in early May in Christmas trees in Grant County. Scotch pine, Douglas fir, and Fraser fir were affected.

Eriophyid Mite - *Trisetacus campnodus* Keifer & Saunders

Scotch pine Christmas trees in Waushara County exhibited injury from an eriophyid mite, *Trisetacus campnodus*. Feeding by this mite caused premature cessation of needle elongation. Affected shoots had scattered needles that were very short. Feeding occurred just as needles were beginning to elongate.

ELM

Elm Leafminer - *Fenusa ulmi* Sundevall

Locally heavy mining of elms, especially red elm was common in Dane and Green counties. This seems to occur every year.

Woolly Elm Aphid - *Eriosoma americanum* (Riley)

There were several reports in Lincoln and Oneida counties about aphids causing unsightly damage to a noticeable percentage of leaves, but overall, damage to trees was low. Natural enemies such as plant bugs and syrphid fly larvae, were frequently found in aphid colonies.

GYPSY MOTH

Gypsy Moth - *Lymantria dispar* (L.)

The effort to slow the spread of gypsy moth populations across Wisconsin continued as thirty-eight spray blocks were treated in 16 counties. Two DC-3 aircraft were used to spray 28,864 acres 2 or 3 times with ½ gallon of B.t.k. per acre. A two-thousand acre block in Sheboygan County was treated with an experimental application of pheromone flakes.

About 49,000 delta traps were placed in 65 counties. A total of 87,749 male moths were trapped in 53 counties (Figure 11).

The egg parasite *Ooencyrtus kuvanae* was released in six locations in NE Wisconsin where there were reproducing populations of gypsy moth, which had been unsuccessfully treated in the past. **See Appendix B for details.**

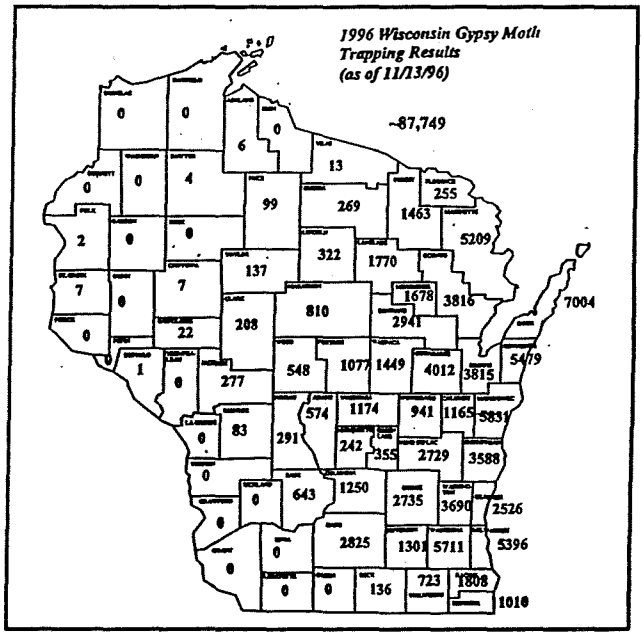

Figure 11. Number of male gypsy moths trapped during the 1996 trapping season.

Six counties in northeastern WI (Brown, Door, Kewaunee, Manitowoc, Marinette, and Oconto) were surveyed for natural enemies of the gypsy moth. Resting spores of the fungus *Entomophaga maimaiga* were recovered from a gypsy moth caterpillar collected from the Black Ash Swamp population in Brussels, Door County. The larval parasite *Cotesia melanoscela* was discovered in a gypsy moth population in Abrams, Oconto County.

The Wisconsin Cooperative Gypsy Moth Program is described in The Wisconsin Gypsy Moth Strategic Plan. An associated Implementation Plan sets annual objectives for the program. Both plans are available from Wisconsin Department of Agriculture, Trade and Consumer Protection, 2811 Agriculture Drive, Madison, WI.

HEMLOCK

Unidentified Decline

During an aerial survey, mature hemlocks scattered along the Popple and Pine Rivers in Florence County were observed to be discolored and appeared to be dying back . The cause could not be identified as the trees were inaccessible from the ground.

HICKORY

Hickory Gall Phylloxera - *Phylloxera caryaecaulis* (Fitch)

Branch and twig dieback was observed on hickory yard trees in Trempealeau County and heavy galling was observed on hickory in LaCrosse County.

LARCH

Larch Needlecast - *Mycosphaerella laricina* (Hartig) Neg.

This disease was late in appearance (almost September before discoloration of foliage occurred) on 10 acres of European larch in Lorain Township of Polk County. Approximately 40% of the trees had symptoms of needlecast.

Larch Casebearer - *Coleophora laricella* (Hubner)

This insect was easy to find on tamarack and European larch in northwestern Wisconsin, but numbers were low enough that little damage was visible.

MAPLE

Sugar Maple Decline Survey - North American Maple Project

Wisconsin continued to participate in the North American Maple Project, administered by the USDA Forest Service and Canadian Forestry Service. Eighteen plots, (Figure 12) (each plot a cluster of 5, 20 X 20 meter plots), were established in 1988; 9 plots have trees tapped for maple syrup, and 9 plots have trees that were not tapped for maple syrup. Each year, data on tree vigor, dieback, discoloration, dwarfing and crown transparency have been collected.

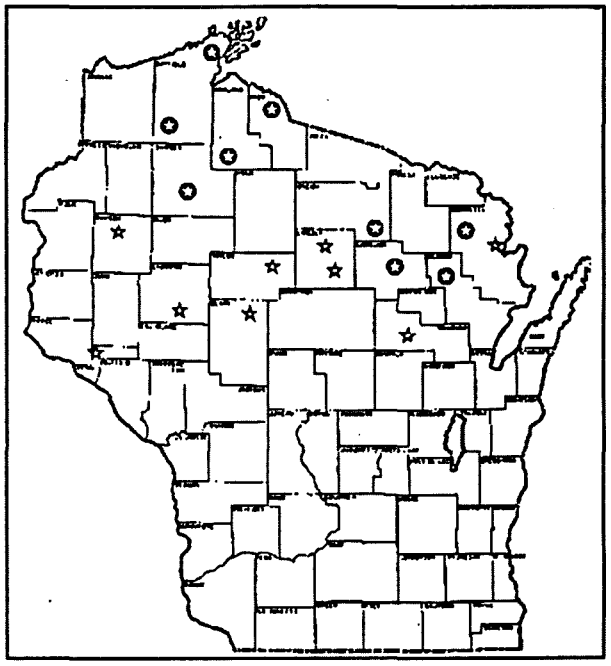

Figure 9. Location of North American Maple
Sugarbush = star
Sugar Maples not tapped = star inside circle

Crown dieback reflects the general, long-term health of individual trees. In 1996, the average plot-cluster dieback of upper crown sugar maples was 10.5% in sugar bushes and 10.1 in non-sugar bushes. These numbers are higher than the 1995 figures of 4.5% and 3.4% in sugar bushes and non-sugar bushes respectively. There was no disturbance reported for these plots. Extremely cold temperatures documented during February, 1996, could have caused some upper crown dieback. Similar injury was documented in northwestern Wisconsin (see Cold Injury). Crown transparency reflects annual fluctuations in tree condition due to disturbances such as defoliation, drought and other stresses. The average plot-cluster transparency of upper canopy sugar maples was 12.1% in sugar bushes and 12.7% in non-sugar bushes; compared to 1995 figures of 10.9% and 11% in sugar bushes and non-sugar bushes respectively. The slight change in transparency is considered within the normal range of expected change. This project will continue for at least one more year.

Linden Looper - *Erannis tiliaria* (Harris)

Loopers caused light to moderate defoliation of sugar maples on Rock Island for the second year.

Sugar Maple Anthracnose - *Discula campestris* (Pass.) Von Arx

In northwestern Wisconsin, anthracnose was common on lower branches and understory trees due to a cold wet spring.

Eriophyes Mite - *Eriophyes spp.*

Silver maple trees displayed red, felt-like patches, called erinea, on the underside of leaves in Monroe and Wood counties.

Cold Injury

Moderate to severe upper crown dieback was observed on approximately 1,500 acres of sugar maple near the city of Mellen in Ashland County, northwestern Wisconsin (Figure 13). Extremely low temperatures (-60 F) caused injury to the trees' cambium.

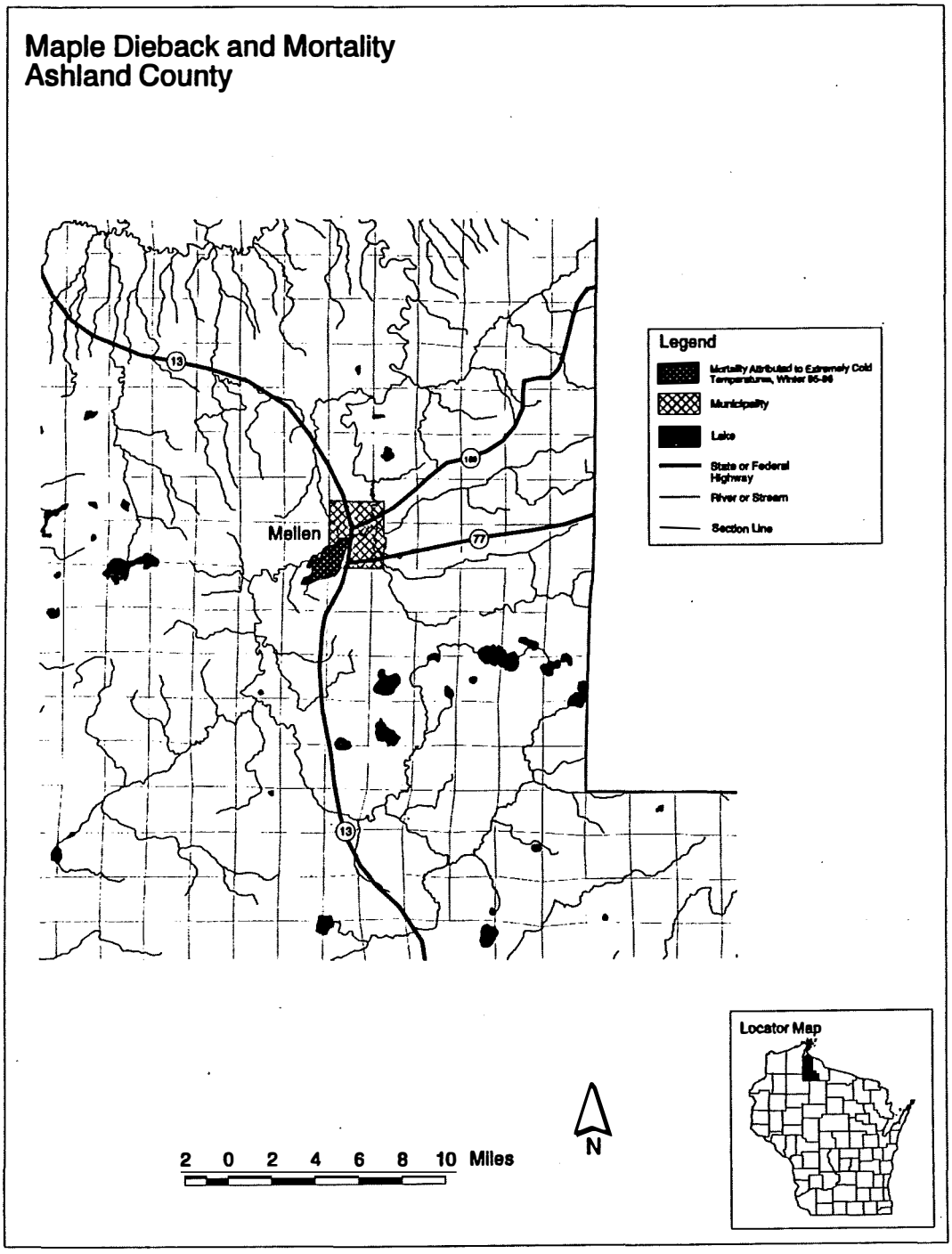

Figure 13. Sugar maple dieback and mortality, Ashland County, WI, 1996.

Maple Trumpet Skeletonizer - *Epinotia aceriella* (Clemens)

This pest contributed to defoliation of maples in late September on the Door Peninsula, Washington and Rock Islands.

Wooly Alder Aphid - *Prociphilus tessellatus* (Fitch)

This insect was quite common on both silver maple and alder in the northwest part of the state.

Winter Sunscald

Several young ornamental red maples in Oneida County developed long vertical bark cracks as a result of winter sunscald. This injury killed many of the trees and also caused partial crown dieback.

MISCELLANEOUS

Fall webworm - *Hyphantria cunea* (Drury)

Fall webworm damage was scattered throughout central and western Wisconsin. Damage was widespread in northwestern Wisconsin, but was not as prevalent as last year.

OAK

Oak Wilt - *Ceratocystis fagacearum* (Bretz) Hunt

This disease was found for the first time in Burnett County, (Figure 15) with two confirmed spots in Anderson township. This was the first new county to be infected in northwestern Wisconsin in over a quarter of a century. Oak wilt continues to kill oaks (primarily northern red and northern pin) throughout it's range in Wisconsin. New locations are often associated with new home construction.

Efforts continue to concentrate on a survey that tests the soundness of guidelines issued by the DNR to minimize the risk of overland spread of oak wilt. This 5-year survey was initiated in 1995 with cooperation from Wisconsin Power & Light.

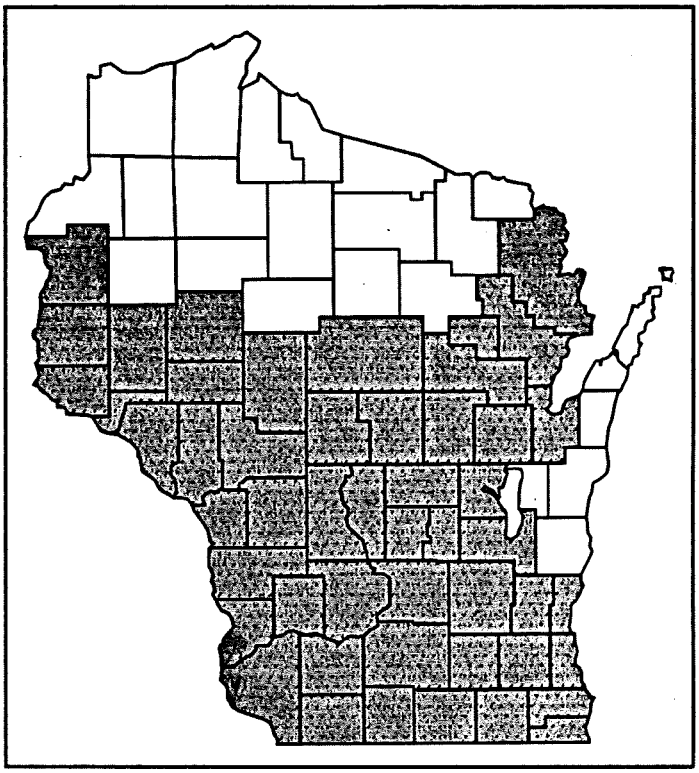

Figure 14. Known county locations of oak wilt in Wisconsin, 1996.

The following practices are being evaluated for their level of risk in contributing to the overland spread:

1. Pruning oaks between **April 15 and July 1; wounds are treated** with a tree wound dressing.

2. Pruning oaks between **July 2 and September 15; wounds not treated** with a tree wound dressing.

Approximately 17 locations in 4 counties were surveyed by ground and air in 1995 (Tables 2-3). Table 2 shows the number of oaks pruned between July 2 and September 15, 1995; Table 3 shows the number of oaks pruned between April 15 and July 1, 1996. All pruned trees were evaluated for symptoms of oak wilt.

Of the 649 oaks pruned between July 2 and September 15, 1995 and not treated with a wound dressing, (Table 2) one had symptoms of oak wilt. A detailed site evaluation revealed a stump from a red oak that had wilted and died within the last 2 years. The stump was within grafting distance of the tree that was pruned and wilted; there were several red oaks that were pruned that showed no symptoms, thus the one wilting tree was likely infected through root grafting.

Table 2. Number of white and red oak group oaks pruned in July, August, and September 1995; no tree wound dressing applied. Oak wilt cooperative survey project, WI DNR and WP&L.

		JULY		AUGUST		SEPTEMBER	
MAP #	County	# OW	# OR	# OW	# OR	# OW	# OR
13 K-48	Sauk/ Iowa	0	26	4	14	0	34
14 K-47	Iowa	0	3	0	4	5	19
15 B-24	Sauk	0	0	0	13	0	0
16 B-11	Sauk	0	107	17	145	0	35
17 B-10	Sauk	18	22	16	25	0	0
18 B-9	Sauk	0	0	0	0	0	0
19 B-4	Sauk	7	36	0	0	0	0
20 C-41	Columb.	0	0	0	0	0	0
21 C-5	Columb.	3	12	13	36	2	2
22 C-6	Columb.	0	0	0	0	11	20
TOTAL		**28**	**206**	**50**	**237**	**18**	**110**

*OW= white oak, OR=red oak.

Of the 292 oaks pruned between April 15 and July 1, 1996 and treated with a wound dressing, (Table 3) one showed symptoms of oak wilt. A detailed site evaluation revealed the wilting tree was on the edge of an expanding oak wilt pocket; root graft transmission was likely the cause of infection.

Table 3. Number of white and red oak group oaks pruned in April, May, and June 1996; tree wound dressing applied. Oak wilt cooperative survey project, WI DNR and WP&L.

		APRIL		MAY		JUNE	
Map #	County	# OW	# OR	# OW	# OR	# OW	# OR
23 K-47	Iowa						
24 K-56	Sauk/ Iowa/ Dane	0	0	5	15	0	14
25 K-55	Iowa/ Dane	0	0	0	0	0	123
26 B-11	Sauk	7	11	0	0	0	0
27 B-12	Sauk	0	0	3	1	8	15
28 B-24	Sauk	0	0	1	8	2	7
28a B17	Sauk	0	0	14	58	0	0
TOTAL		**7**	**11**	**23**	**82**	**10**	**159**

*OW=white oak, OR=red oak.

For the second year, WI Public Service painted pruning wounds on oaks during the period between April 15 and July 1 as part of a study of whether this practice would protect oaks from infection of oak wilt. Of the 22 oaks trimmed and painted during the period, none showed signs of infection later that summer, even though oak wilt is common in the area.

Phomopsis Galls - *Phomopsis* spp.

Galls ranging in size from 1" to 20" in diameter severely deformed a small stand of oaks in Shawano County.

Oak Anthracnose - A variety of fungi

Some white oak that were damaged by oak tatters also suffered from anthracnose in spots in Dane County, but the damage was minor.

The cold wet spring helped produce noticeable browning on lower branches of white oak in Burnett and Washburn counties.

Lace Bugs - *Corythucha arcuata* (Say) and C. *celtidis* Osborn & Drake

High population caused severe bronzing on burr oak in Burnett, southern Douglas, Polk, and Washburn counties.

Gall-like Scale - Kermisidae

Populations were greatly reduced from last year's numbers, but were still present in young red oak plantations in Richland, Grant and Vernon counties.

Branch and twig mortality was observed in a 50 acre oak plantation in Dunn County. The scale was also found on oak saplings in Clark County.

Orangestriped Oak Worm - *Anisota senatoria* (J.E. Smith)

Increased populations caused spots of moderate to heavy defoliation of saplings and light defoliation in mature trees in Adams and Portage counties.

Two-lined Chestnut Borer - *Agrilus bilineatus* (Weber)

Populations have fallen back to endemic levels in northwestern Wisconsin.

Oak Tatters

White oak in the southern counties were severely damaged by this springtime, weather-related phenomenon. Most of the leaf tissue between the veins was missing. The symptoms were distributed from Dodge to Walworth counties in the east to Grant and Lafayette counties in the West. The most severe symptoms occurred in southern and western Dane County where many of the white oak leaves were reduced to shortened midribs with very little additional leaf tissue. Bur and black oaks were affected to a lesser extent.

The more heavily damaged trees rapidly produced new foliage. Some of the less severely affected white oaks produced a new flush of leaves in mid June. The white oak acorn crop was eliminated in the affected area; many of the trees aborted their acorns in early July. Refoliated burr oak were occasionally infested with the jumping oak gall (*Neuroterus saltatorius*).

White oak was also severely damaged this year in Dunn, Eau Claire, and St. Croix counties, and hackberry leaves were tattered in LaCrosse County.

Oak Leaf Tier - *Croesia semipurpurana* (Kearfott)

The pocket in Long Lake township, Washburn County, disappeared as suddenly as it had erupted last year.

Oak Sprout Canker - *Botryodiplodia gallae* (Schwein.)

Oak decline and mortality was observed in a 50 acre plantation in Dunn County. Some trees were heavily infected with the canker; some of the affected trees produced new shoots from the root collar. Oak sprout canker was also observed in Jackson, LaCrosse, and Monroe counties.

Japanese Beetle - *Popillia japonica* (Newman)

This beetle was found at a golf course in Eau Claire County. Adults were found feeding on foliage and larvae were feeding in the greens. Japanese beetle was confirmed by Wisconsin DATCP.

Smooth Patch - *Aleurodiscus oakesii* (Berk. & M. A. Curtis) Hohn & Litsch.

Smooth patch was present on oak in Clark County. The landowner reportedthat bark was falling off of his trees.

Frost Damage

Frost caused moderate damage to small scrub oak in Adams and Juneau counties in late May. The trees put out another flush of leaves a few weeks later

PINE

***See Appendix D for detailed report on red pine mortality in Vilas and Florence Counties, northcentral WI.**

Root Rot of Red Pine - *Heterobasidion annosum* (Fr.; Fr.) Bref. [syn. *Fomes annosus* (Fr.; Fr.) (Cooke)]

This disease was first identified in Wisconsin in 1993 in two locations (Figure 15); on private property in Adams County and on the Arena School Forest in Iowa County. In 1996, efforts concentrated in two areas: 1) locating other root rot pockets within the state and 2) determining the period of spore dispersal from fruiting bodies of *H. annosum* **(See Appendix C).**

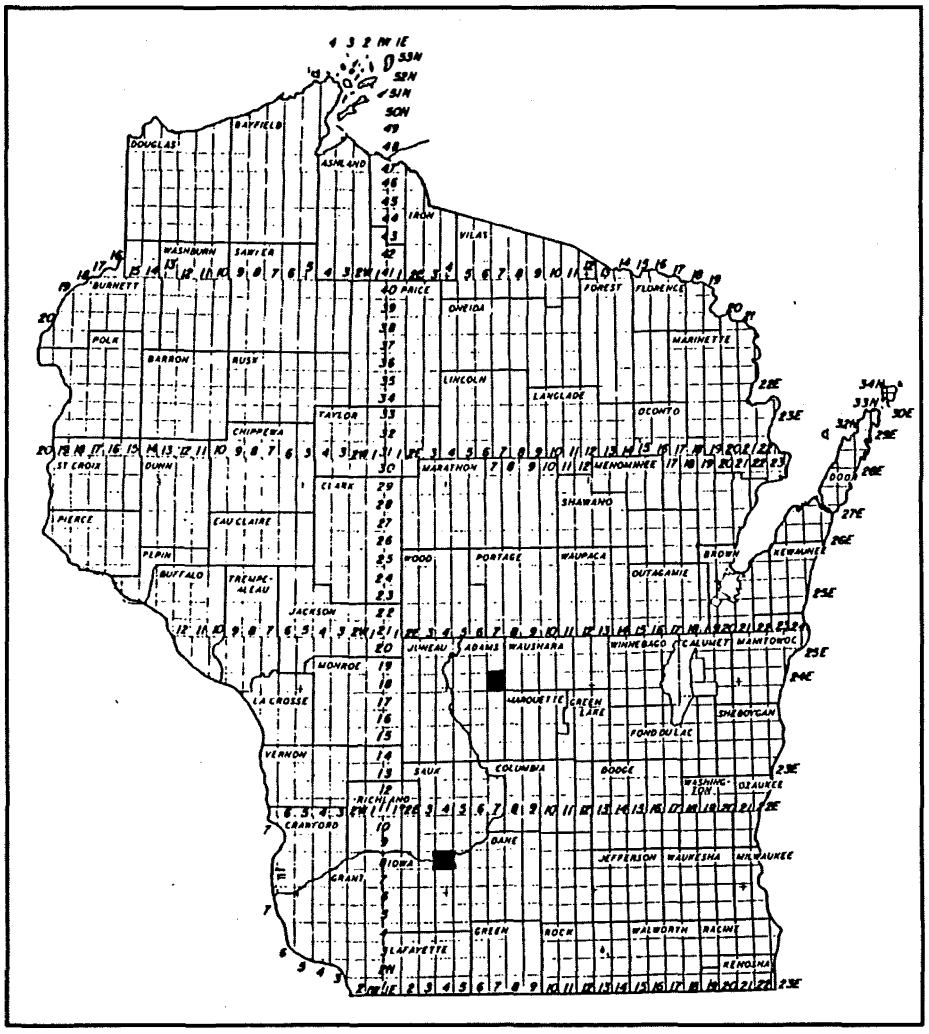

Figure 15. Known township locations of *Heterobasidion annosum* in Wisconsin, 1996.

Survey to locate additional root rot pockets

Survey sites were determined through contacts with state, private and industrial landowners. Ten sites were visited during the growing season in 1996 (Figure 16); two in Wood County, two in Trempealeau County, three in Portage County, one in LaCrosse County, one in Iowa County, and one in Adams County. All sites had red pine plantations that had received at least one thinning except the Iowa County site which contained white pine. All sites with red pine had dead and dying trees; trees dead the longest were surrounded by dying trees in a typical root rot pocket pattern.

Excavation of the soil and roots around dead and dying trees revealed a variety of red pine pests typical in these pockets. Pests and signs of pests included Armillaria root rot, root collar weevil and turpentine beetle and blue stain (most likely caused by species of fungi in the genus *Leptographium*). Some locations revealed none of the pests or symptoms listed above. Samples were collected from roots that were thought to be infected with *H. annosum,* yet **no *H. annosum* was detected in any of the sites surveyed.**

The wide variety of pests and symptoms observed prompted the initiation of a research study in cooperation with the University of Wisconsin, Department of Entomology. This study will begin in 1997 and will investigate the factors influencing the initiation and development of these areas of red pine decline and mortality.

Aerial survey of southern Wood and northern Adams counties

An aerial survey, conducted in cooperation with forest land managers from Georgia Pacific, revealed the presence of additional areas of red pine decline and mortality in southern Wood and northern Adams counties (Figure 17). These areas will be examined in 1997 as candidates for research study sites.

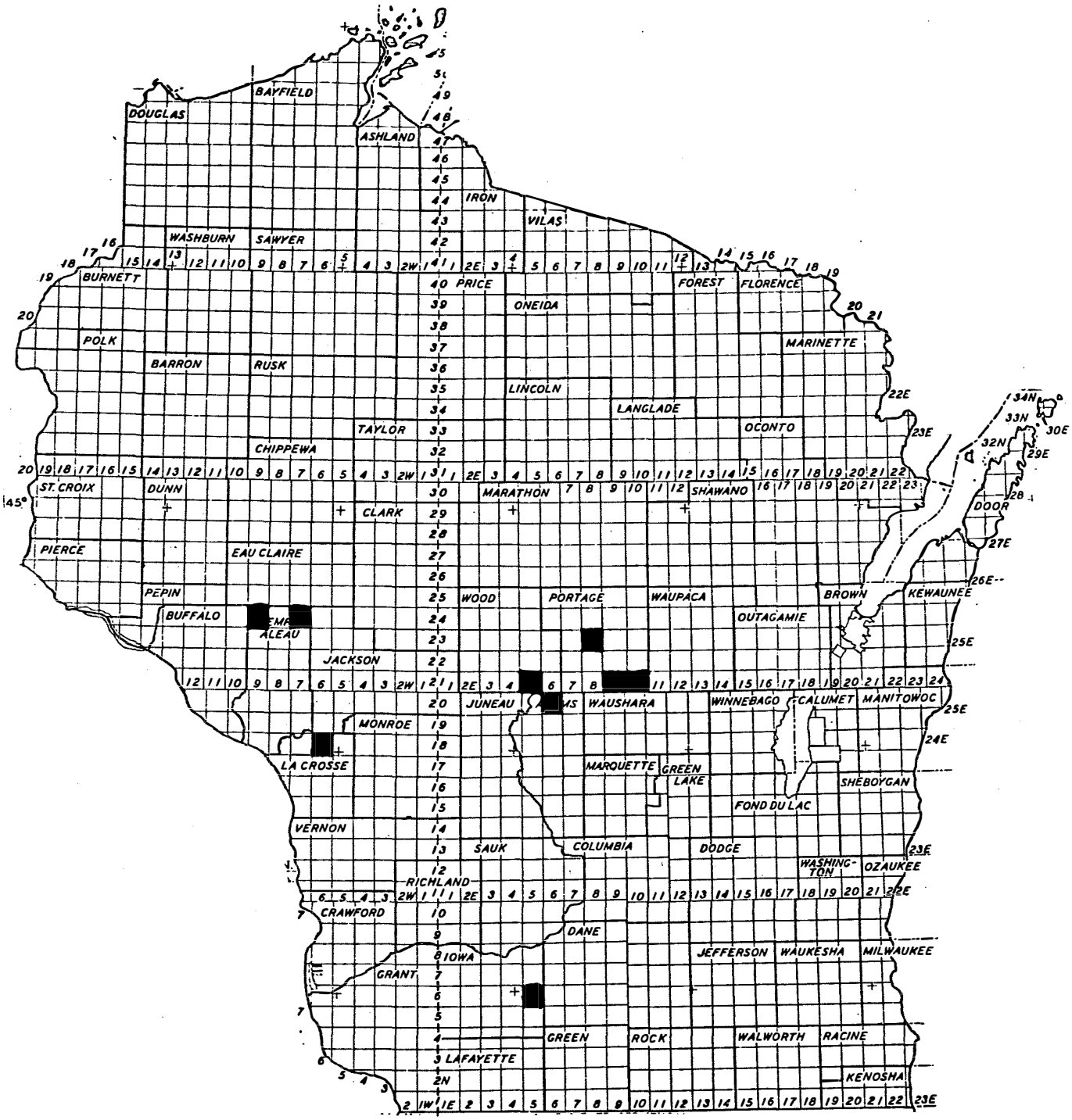

Figure 16. Red pine root rot surveys areas, Wisconsin, 1996.

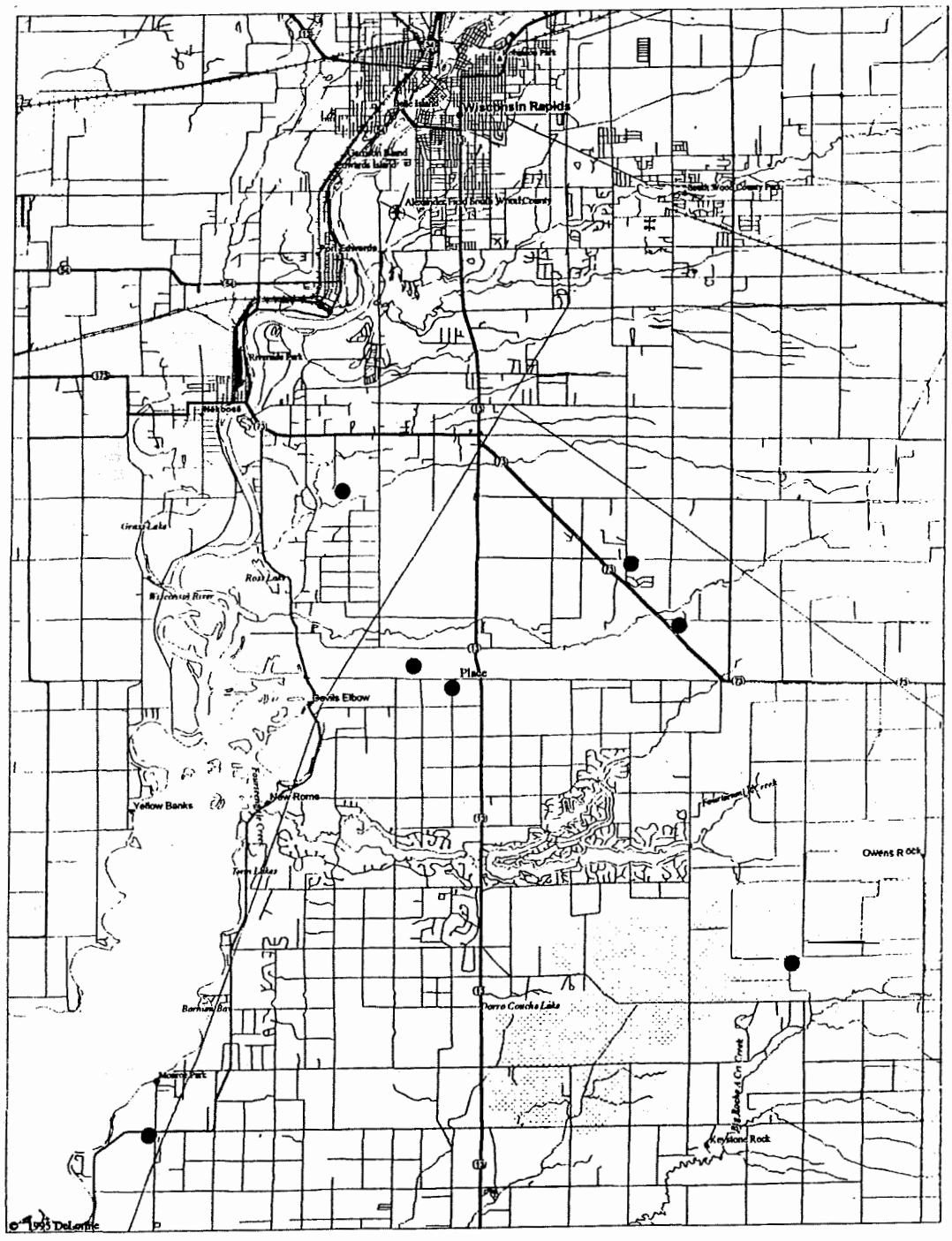

Figure 17. Areas of red pine decline and mortality, Adams and Wood counties, DNR and Georgia Pacific aerial survey, 1996.

Red Pine Shoot Blight - *Sirococcus conigenus* (DC.) P. Cannon and Minter

The known county locations of this disease did not change in 1996 (Figure 18).

A stand of six-year-old red pine in the Northern Highland State Forest was severely infected by Sirococcus shoot blight (SWNW Sec. 24 T42R6E). Nearly every tree in this 27 acre plantation had dead shoots, and many had dead terminals or were completely dead.

Red pine mortality also occurred in long-term Sirococcus study plots in the Northern Highland-American Legion (NHAL) State Forest. Symptoms of 1995 infections were evident in some understory red pine near Star Lake, NHAL State Forest.

An investigation on the long-term impact of this disease on red pine on the NHAL State Forest was initiated in 1994. This project is being conducted by the USDA Forest Service, S& PF, and will continue in 1997.

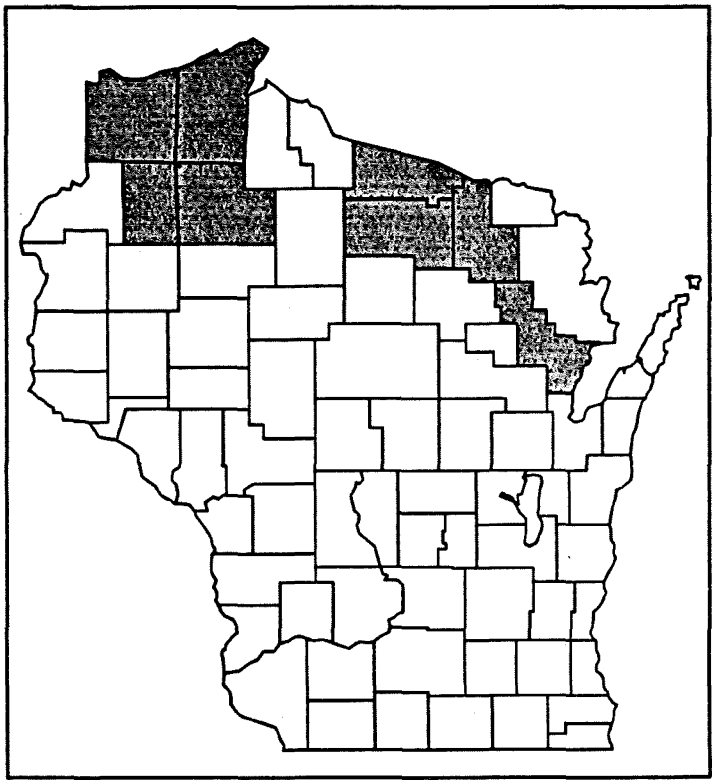

Figure 18. Known county locations of Sirococcus shoot blight in Wisconsin, 1996.

Fir Coneworm - *Dioryctria abietivorella* (Grote)

In Waushara County there was an unusual occurrence of this pest (which often attacks spruce and fir cones) on white pine branches.

Red Pine Shoot Moth - *Dioryctria resinosella* Mutuura

This shoot borer attacked large numbers of shoots on red pine windbreaks and plantation edges in Columbia , Marquette, and Waushara counties. Interior trees in plantations were not damaged.

Shoot damage was also found in yard and windbreak red pine in Chippewa, St. Croix, and Trempealeau counties.

Red pine shoot moth caused light to moderate damage to red pine in Adams County. Trees affected were as young as 12-years-old, which is uncommon for this insect.

Northern Pitch Twig Moth - *Petrova albicapitana* (Busck)

The second-year pitch nodules of this twig girdler were common on jack pine branches in some stands in Oneida County. Infestations were light, but infested shoots died or became weak and prone to breakage.

Red Pine Decline - Unknown

A naturally regenerating red pine stand, approximately 1-4 years old, is declining in Monroe County. A multitude of factors seem to have contributed to the decline: the hot summer of 1995, the long cold winter of 1995-96, flooding the spring of 1996, insect borers, and Sphaeropsis collar rot. Collar rot is infecting a majority of the dead and dying trees here.

White Pine Branch Mortality - Unknown

A white pine stand, approximately 30-38 years old, is declining in Monroe County. Mortality is occurring in pockets. Surrounding trees are exhibiting branch flagging similar to white pine blister rust, although blister rust is not present. Results from the isolation of samples confirm that neither Sphaeropsis nor Nectria are present either. Cause of this decline is unknown. This stand will be mapped in 1997 and data on the health status of trees within the stand will be noted.

Shoot Breakage

Damage to shoots of red pine 10 to 20 feet tall was common in plantations in the Northern Highland State Forest in Vilas County. Terminal and/or lateral shoots of the top whorl were bent downward at their bases as if a heavy animal had hung on them. Black scat on several of the shoots indicated a small mammal was the culprit, possibly a red squirrel. The trees were too young to have cones.

Jack Pine Budworm - *Choristoneura pinus* (Rohwer)

Budworm caused light defoliation of open grown, mature jack pine in Marinette County. Populations remained very low in Clark, Dunn, Eau Claire, Jackson, and Monroe counties.

Egg mass counts indicated there could be more defoliation in the northwest Wisconsin (Barnes and Highland townships) in 1997.

In the Northern Highland State Forest 68 plots were chosen from maps and inventory data to be the new long-term jack pine budworm sample plots. The former set of plots was disregarded because many stands had been cut in timber sales. The new plots were at least 25-years-old, over 25 acres in size, and were prioritized according to their susceptibility to budworm defoliation and damage.

Priority 1: Over 45-years-old, sampled every year for budworm.

Priority 2: 35-45 years-old, sampled when budworm populations are increasing.

Priority 3: 25-34 years-old, sampled when budworm populations are at outbreak levels.

Since this is the first year with these new sites, all sites were sampled. The survey type is a late larval survey of two 15-inch branches from three trees in each plot, for a total of six branches per plot. Populations were very low in all plots, with 42 of the 68 plots having no budworms on the sample branches. The plot with the highest population had an average of 1.17 budworms per branch.

No defoliation by the jack pine budworm was noted in an aerial survey of the Northern Highland State Forest in August.

Pine Tussock Moth - *Dasychira pinicola* (Dyar)

There was a complete collapse of pine tussock moth in the northwest in 1996.

Pine Needle Rust - *Coleosporium asterum* (Dietel) Sydow

Present in the northwest, but not as prevalent as expected given the wet spring and early summer.

Grasshopper Damage

Forty acres of white pine seedlings in Manitowoc County were damaged by grasshoppers following haying in adjoining fields in August.

Red Pine Sawfly - *Neodiprion nanulus nanulus* Schedl

One colony found in Solon Springs, Douglas County.

Introduced Pine Sawfly - *Diprion similis* (Hartig)

Small numbers of sawflies were found feeding on white and jack pines scattered throughout western Wisconsin. Sawflies were also found feeding on river birch and bush honeysuckle in a yard in Eau Claire County, although they did not attack the white or red pines in the yard.

There was little damage by the introduced pine sawfly in the northwest. A large migration of larvae moved into the Hayward Nursery in September, but they pupated (cocooned) before doing significant feeding on seedlings.

Saratoga Spittlebug - *Aphrophora saratogensis* (Fitch)

Declining but damaging populations hit Price County this year. Elsewhere in the northwest numbers dropped dramatically with almost no new damage.

Surveys for spittlebug nymphs are conducted every year in red pine stands in the Northern Highland-American Legion State Forest. Of the 68 stands surveyed this year, one had high populations of nymphs. This 65-acre stand was aerially sprayed (helicopter) with Malathion on August 10 to prevent adult feeding and egg-laying. The treatment was very successful, with no adults being found in sweep net counts two days later. The stand is located in Vilas County.

An eight-acre stand of red pine planted in the mid-1980s had severe branch and tree mortality since the previous year. It is located in the Northern Highland State Forest in Vilas County near Tower Lake. The damage was mainly in pockets that are depressions in the topography (potential frost pockets). The heaviest damage appears to be from Saratoga spittlebug feeding. Many of the branches also had cracks in the bark from winter injury. Yellowing in the trees was first noticed last year. Surveys for spittlebug nymphs in 1995 did not indicate that populations would reach damaging levels.

Pine Spittlebug - *Aphrophora cribrata* (Walker)

Pine spittlebug was present in moderate numbers in the northwest but causing little, if any, significant damage.

Populations of pine spittlebug nymphs on ornamental white pine were higher than normal this summer in the Wisconsin Rapids area of Wood County. No noticeable damage occurred.

White Pine Aphid - *Cinara strobi* (Fitch)

Populations were present in the northwest but at levels no worse than usual.

Pine Tortoise Scale - *Toumeyella parvicornis* (Cockerell)

In the northwest region this pest was present in usual numbers.

Tortoise scale was present on mature and younger jack pine, including waist-high reproduction, in Portage County. The scale caused mortality in all age groups and heavy black sooty mold was present.

Pine Engraver - *Ips pini* (Say)

A red pine plantation in Dunn County was heavily hit by bark beetles; the plantation was severely damaged by a storm earlier in the year. A salvage harvest was conducted in the plantation. Bark beetles were still active in the weakened jack pine in Eau Claire, Jackson, and Monroe counties where the jack pine budworm outbreak occurred in 1992-94.

A large pocket (200 + trees) was found this year in Burnett County, following a multiple lightning strike. Bark beetles also killed off approximately 15 acres of fire damaged red pine in Burnett County.

Red Turpentine Beetle - *Dendroctonus valens* LeConte

The turpentine beetle was present in large numbers in fire damaged red pine in Burnett, Douglas, and Washburn counties, and on scattered declining individual red pine in older plantations.

Pine Root Collar Weevil - *Hylobius radicis* Buchanan

There was very little damage to red pine in northwestern Wisconsin, but there was some severe damage to Scotch pine in Washburn County.

Prolepsis of Red Pine (Abnormal late-season flushing of lateral buds)

Proleptic growth was the rule rather than the exception in red and white pine in the northwest. Very heavy proleptic growth occurred in 5-year-old red pine plantations in Columbia and Marquette counties.

Sphaeropsis Shoot Blight - *Sphaeropsis sapinea* (Fr.:Fr.) Dyko & Sutton in Sutton

Sphaeropsis infection was found in red pine regeneration, windbreaks, and yard trees in Chippewa, St. Croix, and Trempealeau counties.

Shoot blight damage was widespread on young (3-8 years old) red pine in Bayfield, Burnett, Douglas, Polk, and Washburn counties. Plantations in low lying areas were extremely hard hit, with mortality exceeding 60% in some plantings. The towns of Springbrook (Washburn County), Wascott (Douglas County), and Barnes (Bayfield County) appeared to have the most damage.

About 3 acres on the outside edge of a red pine plantation in Marinette County were infected by Sphaeropsis following heavy damage from hail. Mature pines and seedlings in the understory were killed though the disease was limited to that one small area.

Zimmerman Pine Moth - *Dioryctria zimmermanni* (Grote)

This moth was found in scotch pine plantations in Buffalo County and also on jack pine in Chippewa County.

Pales Weevil - *Hylobius pales* (Herbst)

Feeding damage was found on white pine regeneration in a red and white pine plantation in Adams County. The plantation had been recently thinned.

Armillaria Root Rot - *Armillaria mellea* (Vahl:Fr.) P. Karst.

Armillaria was found in the LaCrosse County Forest on red pine. Trees are dying, but it is uncertain if Armillaria is the cause.

A Pine Sawfly - *Neodiprion maurus* Rohwer

Colonies of this sawfly were common in some jack pine stands in Oneida County. They fed on old foliage, causing only very light defoliation. Late instars were still feeding on the pine in mid-July. This species has one generation each year.

Red Pine Mortality - Unknown Causes

Scattered individual red pine trees were dying in a 55-year-old stand in Wood County. The stand had been thinned twice, and the dead trees were dominant overstory trees. Bark beetles and other phloem and wood borers were involved in the trees' demise, but were not the initial factor. Armillaria was also prominent in the large roots of two of the dead trees, but had not worked its way into the boles.

Strawberry Root Weevil - *Otiorhynchus ovatus* (L.)

White pine twigs that were girdled by the strawberry root weevil last fall in Columbia County, fell off in early May.

Salt Damage

Road salt damage to red and white pine was extensive along major roads throughout northern Wisconsin during the '95-'96 winter. Salt spray coated the trees this winter and caused needle desiccation in the spring. Red, partially-dead needles remained on the trees through August. A secondary fungus was found on many of these needles. New shoots and needles that grew in the spring of 1996 were healthy.

Snow Damage

A 27 acre red pine plantation in Vilas County sustained many broken and bent branches and terminals from the weight of heavy snow during the winter of 1995-96.

Winter Burn

Winter injury occurred on young red, Scotch, and white pine in northern Wisconsin. In many areas, all needles above the snow line were red in the spring. These needles were shed, and the new shoots appeared to be healthy.

SPRUCE

Chlorosis of Spruce Needles - Unknown

Spruce plantings in St. Croix County displayed yellowing of older needles while current years growth remained green. Excavation of root systems revealed no root rot pathogens. Nutrient imbalance is suspected of contributing to the chlorosis.

Rhizosphaera Needlecast - *Rhizosphaera pini* (Cda.) Maubl.

This needlecast disease was present on yard trees and nursery stock in St. Croix County and was very common on blue spruce in Bayfield, Burnett, Douglas, and Washburn counties.

Infections in blue and white spruce ornamentals were reported in Marathon and Vilas counties.

Spruce Budworm- *Choristoneura fumiferana* (Clemens)

Early larval surveys from spruce plantations in Marathon and Wood counties indicated budworm populations were low and no noticeable defoliation should have occurred in 1996; however, there was some light defoliation.

A spruce plantation in Stinnett township, Washburn County, was heavily damaged - particularly the edge trees. Adjacent balsam fir were untouched.

Spruce budworm populations were down in a 58-year-old white spruce stand in Wood County after it was thinned last winter. Defoliation was very light this year.

Light to moderate defoliation occurred in a dense stand of white spruce in Marathon County. Egg mass surveys on July 18 revealed an average of 0.38 new egg masses per branch, which is similar to the results of 0.45 in the 1995 survey. Within each of four plots in the stand, two 15 inch branches were sampled from each of the three trees.

Yellowheaded Spruce Sawfly - *Pikonema alaskensis* (Rohwer)

An off year for this perennial pest in the northwest, with only scattered light damage.

Spruce Needle Rust - *Chrysomyxa spp.*

This year had the heaviest needle rust on blue spruce in the northern Wisconsin. The heaviest damage occurred between Rhinelander and Eagle River, where most blue spruce looked yellow-orange from a distance. Though not as spectacular, all blue spruce from Washburn County to the east, had high levels of rust infection.

Severe infections occurred on many ornamental Colorado blue and white spruce in Marathon, Oneida (especially Pelican Lake and Three Lakes), and Vilas counties in late July. The below average temperatures contributed to the delay in development of the rust. Infected needles remained on the trees throughout August. Trees with severe infections appeared to be yellow-orange from a distance.

White Spruce Mortality - Unknown Causes

A white spruce plantation in Wood County had several pockets in which trees were turning yellow and dying. Soil and foliage samples were submitted for nutrient analysis.

Spruce were turning yellow and new shoots were browning, curling, and dying in a spruce plantation in Jackson County. This could be due to a combination of the hot weather in 1995 and the cold winter in 1995-96, or nutrient deficiency since the trees were planted on sandy soil.

Deformed Spruce Growth

In a white spruce plantation located in Pierce County new growth had shortened, twisted needles. On some trees growth and bud set was restricted to one location. This could be due to herbicide injury.

WILLOW

Giant Elm Sawfly - *Cimbex americana* (Leach)

Sawflies defoliated large willow yard trees in Chippewa and Clark counties.

Willow Dieback

Willow yard trees had significant dieback in St. Croix County. Willow shoot blight canker was found on the dead and dying branches.

Imported Willow Leaf Beetle - *Plaiodera versicolora* (Laicharting)

Larvae and adults caused significant defoliation on several large ornamental willows in Rhinelander and Oneida counties.

WEATHER AND WILDLIFE

Winter Burn

White, red, and scotch pine needles turned red in fields and Christmas tree plantations in western Wisconsin.

In northwestern Wisconsin, virtually every species of conifer had winter burn. Scotch pine, white pine, and arborvitae were especially hard hit.

Winter Injury/Mortality - Extremely low temperatures

Severe winter injury/mortality occurred on trees and shrubs throughout western and central Wisconsin. Extremely low temperatures (-50 to -60 degrees F), recorded in February are likely to have caused mortality of shoots and patches of cambium. Species affected included: ash, balsam fir, birch, fruit trees, junipers, hard and soft maples, spruce, and yews.

Frost

Late spring frost damaged young oak and walnut seedlings and completely defoliated sapling black walnuts in frost pockets in Green County.

Flood Damage

Standing water for several months in spring and early summer killed arborvitae, spruce and assorted hardwoods in Winnebago County

Squirrel and Porcupine Damage

In western Wisconsin scattered trees were damaged by squirrels and porcupines that stripped bark from trunks during the winter. Species affected include: aspen, maple, oak, white pine, and tamarack.

Road Salt Injury

White, red, and scotch pine needles turned red along highways and roads in western Wisconsin.

APPENDIX A

NEEDLECAST DISEASES OF BALSAM FIR CAUSED BY: *Lirula nervata and Lirula mirabilis*

Jane Cummings Carlson

Introduction

Two fungi that are not new to Wisconsin, yet are new to Wisconsin's balsam fir[1] Christmas trees, were studied during 1995 and 1996. These 2 fungi, *Lirula nervata* and *Lirula mirabilis* were documented as being present in Wisconsin's native balsam fir forests in the 1960's. In 1995, symptoms commonly associated with needlecast fungi started appearing on Wisconsin's balsam fir Christmas trees. Symptoms primarily included browning of second-third- and fourth-year needles. The sudden appearance of these fungi on Christmas trees can most likely be attributed to the cool, wet growing season of 1993. Many fungi capable of causing needle infections did so during 1993 and symptoms of most of these began to show in 1994 and 1995.

This study was initiated to answer the following questions:

What are the symptoms and signs of these diseases?
What is the life cycle of these fungi?
What are the environmental and site conditions that lead to infection?
What cultural practices are most productive in managing these diseases?

Materials and Methods

In 1995, spore traps were placed throughout a heavily infected stand of balsam fir Christmas trees in Florence County, northeastern Wisconsin. The spore traps consisted of glass slides coated with Vaseline. The slides were mounted on wire slide-holders, approximately 2 feet off the ground. Half of the slides were protected from the rain, half were left out in the open. The slides were changed every week for 3 months. The slides were examined for the presence of ascospores of *Lirula nervata* and *L. mirabilis*. The number of spores detected during the 3 months of exposure was very low and it was nearly impossible to distinguish between ascospores of *Lirula* spp. and *Lophodermium* spp. thus, the data was not considered valid.

[1]These fungi have been observed on balsam fir only. We do not know if Fraser is a host; growers should be On he look out for these diseases on Fraser fir. Douglas-fir is apparently not a host for these fungi.

In 1996, a weather station and rain gauge were set up in the plantation to monitor minimum and maximum temperature every hour, relative humidity and rain fall. Samples of diseased foliage were collected once a week from May through September. Infected foliage was examined in the laboratory to determine when spores were maturing and being released.

Observations were made during 1995 and 1996 regarding symptom development and life cycle.

Results & Discussion of Disease Management

Symptoms:
Both species of *Lirula* have a two-year life cycle (two years from infection to production of infectious spores). Only current year's foliage is susceptible to infection. Infected current-year foliage remains green, showing no symptoms until the following spring. Infected second-year foliage is brown, and the infected third-year foliage bleaches to a straw or tan color. Discolored needles may be shed or be broken off int he third year, or they may remain attached for a few years.

Injury from these pathogens ranges from scattered brown needles to the loss of most of the three- and for-year-old needles. Most of the affected foliage is in the lower branches where humidity and moisture are higher throughout the growing season.

Signs of Disease and it's Life Cycle
During the summer, ascospores infect the current year's needles. Needles are infected individually and the fungus does not spread into the adjacent needles or the twig. The newly infected fir needles remain symptomless until the following spring when they begin to discolor. Infected needles then become pale and patchy green in color and slowly turn brown as they die. Pycnidia (fungal spore-producing structures that appear as blister-like ridges) develop in the upper surface of these brown needles in late spring on the second year and mature during the summer. Spores produced int he pycnidia presumable do not infect fir needles.

In late summer of the second year, an ascoma (a second type of spore producing structure) begins to form on the midrib in the lower surface of the needle. As the ascoma matures, it will look like a dark line along the lower midrib. During rain, the ascoma opens and infective spores called ascospores are released. Ascospores are presumable wind-borne.

Timing of Spore Dispersal

Observations of the infected foliage throughout the growing season revealed the following: ascospores first matured in mid-May and were observed in the ascoma through mid-July. Thus, any fungicidal spray would have to be protecting current year's needles from mid-May through mid-July. There are currently no fungicides specifically registered for managing these diseases on balsam fir; products containing chlorothalonil have been shown to be effective controlling other *Lirula* species on spruce yet have not been tested on balsam fir.

Management of Disease through Cultural Techniques

Observations of this disease have lead to the development of cultural management techniques. Fungicidal sprays are probably not necessary if the following cultural controls are used:

Do not grow balsam fir in areas where cool moist air collects and stagnates on a daily basis during the growing season. Locate plantations in areas where there is good air drainage.

Carefully examine any native balsam fir for infected needles before planting. Do not introduce these diseases by transplanting infected native balsam fir.

Do not interplant balsam fir in infected portions of balsam fir plantations, as it tends to perpetuate the disease in the stand.

Provide adequate space between trees, prune off lower branches and control weeds to allow more air flow.

Do not leave live, infected branches on stumps of harvested Christmas trees; they serve as disease reservoirs.

Shear healthy plantations first so disease spores will not be carried into them from infected plantations.

Do not shear infected foliage during wet weather because spores released at this time may be carried form tree to tree on shearing tools. Sterilize tools after shearing infected plantations by dipping in denatured alcohol for 3 minutes.

If needlecast is a repeated and economic problem in your plantation, grow a species other than balsam fir.

A color booklet showing symptoms and signs of these diseases along with cultural management recommendations is available free of charge from Jane Cummings Carlson, (608) 275-3273.

APPENDIX B

INTRODUCTION SITES OF *Ooencyrtus kuvanae*, FALL 1996

Andrea Diss

Marinette County

Grover, T30 R22 Sect 19: area has been sprayed twice, abundant moth catch in 1996, two egg masses found within half hour of search. Scrub willow and trembling aspen dominate the site.

Oconto County

Abrams, T26 R20 Sect 2: area has been sprayed once, moths abundant following spray, many larvae were found during the summer; 15 egg masses were found in less than half an hour of searching. Cover is almost exclusively scrub willow.

Little River, T29 R21 Sect 34: area has been sprayed twice, trap catches numbered 17 and 12 in adjacent traps along a wooded ditch predominated by scrub willow and bordered by a fallen stone wall. Three egg masses were found within minutes, and more had been removed by previous searchers.

Door County

Forestville, T26 R25 Sect 31: area has been sprayed in the past, but this swampy woods and adjacent Black Ash Swamp have been strongholds of the gypsy moth for several years. Trap catches in 1996 were 81 and 55 in neighboring traps. Five egg masses were found within minutes of entering the woods and there are undoubtedly more in the over-mature birch and willow at this site. The introduction here will hopefully serve as a nursery from which *O. kuvanae* could be collected for future redistribution.

Manitowoc County

Newton, T18 R23 Sect 34: area has been sprayed twice, but gypsy moth persists in the burr oaks and trembling aspen of this woodlot. After egg mass surveyors had removed 14 new egg masses, at least nine remained too high in the trees to be removed.

Point Beach State Park: this park was mass trapped, but numbers of moths are high again, even in a year where there was no apparent blow-over from Michigan.

T20 R25 Sect 31: on the southern border of the park 47 moths were caught in a grove of over-mature and multi-trunked white birch, mixed with tamarack. No egg masses were found within half an hour of searching, but the abundance of hiding places high on the trees may be the reason for the lack of success.

T20 R25 Sect 20/29 (border): this site along the Molash Creek in the center of the park has been a traditional site where gypsy moth egg masses are found. On this visit none were found, though trap catches were well targeted with 25, 16, and 18 in close proximity. The dominant hosts at this site are hemlock and yellow birch, which makes searching for egg masses more difficult.

T20 R25 Sect 4: on the northern border of the park, a trap catch of 29 lead to an egg mass under the bark of a dead branch on a mature red oak. Oaks and maple dominate this drier woodland and the oaks may account for the high trap catches we have seen in this area for several year.

APPENDIX C

HETEROBASIDION ANNOSUM: MONITORING THE TIMING OF SPORE DISPERSAL

Jane Cummings Carlson, Dr. Glen Stanosz[2] & Kevin Engelien[3]

Introduction

In 1993, Dr. Glen Stanosz, University of Wisconsin, identified and observed *Heterobasidion annosum* causing root rot, decline and mortality of red pine in a plantation in Adams County. Subsequently, Dr. Stanosz also confirmed the presence of this fungus in a red pine plantation in Iowa County. These are the only 2 confirmed locations of this root rot in the state of Wisconsin. Aerial and ground surveys have revealed the presence of pockets of dead and dying red pine in red pine plantations throughout central and southern Wisconsin and occasionally in western Wisconsin. Selected plantations have been visited yet signs of *H. annosum* have not been observed nor has the pathogen been isolated from these areas. As survey efforts continue to focus on locating this pathogen in other areas of the state, a method was tested for determining the timing of spore release from basidiocarps of *H. annosum.* Management of *H. annosum* could include limiting thinnings of red pine plantations to times when spores are not being dispersed. Infection most often occurs through freshly cut stumps. After invasion of the stump, the pathogen moves into the root system and infects healthy pines by moving along connected root systems. Data is available from the southern United States but is not for the Lake States region.

Materials and Methods

The two study sites, where *H. annosum* has been confirmed, were located in Adams County on private property (T18 N, R7E, Sec. 29, SE1/4; and Iowa County, on the Arena school forest (T8N, R4E, Section 23, NW1/4). The Adams County site is a 38-year-old red pine plantation that was thinned in 1986 and 1996. Some residual slash covered the ground on this site and scattered red and white pine seedlings were also present. The Iowa County site is a 41-year-old plantation that was last thinned in 1992. The stand consists of an understory of white pine, oak, red pine and raspberry in the opening created by the root rot pocket.

[2]Department of Plant Pathology, University of Wisconsin, Madison, WI 53706.

[3]Bureau of Forestry, Department of Natural Resources, Madison, WI 53711.

In May, 1996, a healthy red pine was felled and approximately 150 disks (1" X 5") were cut and placed into plastic garbage bags. The disks were kept in a freezer, in the plastic bags until needed for the survey. Every two weeks from early June through early November, 12 disks were taken from the freezer and placed on stumps in the root rot pockets at each of the two sites (6 disks at each site). Each time a fresh set of disks was placed on the stumps, each exposed disk was placed into autoclaved plastic bag that also contained a moist paper towel. The exposed disks were taken back to the laboratory and allowed to incubate for 2-4 weeks at approximately 70 degrees F. After incubation, the disks were examined under a dissecting microscope for the presence of conidiophores of *H. annosum*. The presence of basidiocarps was noted throughout the survey season; basidiocarps were observed on 4 of the stumps (2 at each site) where disks were placed.

Results and Discussion

Of the 144 disks placed in the field, only one supported growth of the fungus, *H. annosum*. These results were surprising as this method of monitoring spore dispersal is established in the literature and these disks were placed in known root rot pockets. Two factors that could have potentially caused an unfavorable environment for the fungus are 1) the disks were frozen and not freshly cut and 2) the moisture content in the incubation bags was too low or too high. The moisture content in the incubation bags varied greatly. Some were very wet with moisture dripping onto the disk and some were quite dry. The one disk that supported growth of the fungus appeared drier than most disks. Some disks were heavily colonized by *Penicillium* spp. and *Trichoderma* spp. The disk supporting *H. annosum* was also heavily colonized by both of these fungi.

The lack of colonization of the disks by *H. annosum* has left us without any further information regarding the timing of spore release. Efforts in 1997 will continue on refining this survey technique.

APPENDIX D

RED PINE SHOOT MORTALITY AND TOP DIEBACK VILAS, MARINETTE AND FLORENCE COUNTIES

Jane Cummings Carlson

Reports of shoot mortality and top dieback of red pine were detected in three locations in 1996 - Vilas County, (Sec. 10, T41N, R10E; Sec. 13, T42N, R8E), Florence County (Sec. 31, T39N, R19E). Four factors were determined to be contributing to the symptoms. They appear to be present on all three sites but at various levels of intensity.

Factor 1: Saratoga Spittlebug - *Aphrophora saratogensis*

Feeding scars were evident on 1995 and 1994 growth on all three sites. The incidence of feeding scars was low to moderate and only occasionally were prevalent enough to cause shoot mortality. Injuries from spittlebug were not considered significant enough to have caused the widespread dieback and mortality.

Factor 2: Burn Blight - *Chilonectria cucurbitula*

This fungus was described as causing top and shoot dieback on red and jack pine in Wisconsin and Michigan in the 1940's. *C. cucurbitula* was found fruiting on dead terminals and an occasional lateral; it was also associated with spittlebug feeding. Although it's presence contributed to the problem, this fungus is not likely to be a significant contributor to the mortality.

Factors 3 & 4: Shoot Mortality & Bark Splits - Freeze injury

There is significant evidence to support the occurrence of 2 major freeze injury incidences. They manifested themselves in 2 different ways. One was an outright killing of the youngest shoot growth. A common symptom of this type of freeze injury is the presence of a discolored pith that initiates in the dead shoot and progresses into the green or "healthy" tissue. This symptom was observed on virtually every dead shoot. No shoot pathogens were observed or isolated. The second symptom was the presence of numerous wounds or bark splits on many of the affected trees (a well documented symptom of freeze injury). These splits varied in size and shape and often looked like hail wounds yet the pattern of dispersal on the trees could not have been caused by a hail storm. The wounds were dated and the data points to two freeze events; one between 9/1/94 and 5/1/95 and the other between 9/1/95 and

5/1/96). These freeze events occurred sometime from early fall through spring; they did not occur during the growing season. The cross sections of affected areas also revealed the presence of a "freeze ring" or brown ring of tissue, another symptom of freeze injury.

The weather data clearly explains how freeze injury could have occurred during the dormant season of 1995-96 (Figure 19). The temperatures recorded at Eagle River reached nearly -40° Fahrenheit and the temperatures in the frost pockets or in areas where cold air could drain and be trapped were likely to be lower. Temperatures 10 degrees lower in valleys than on ridges have been recorded in southern Wisconsin. Explaining injury during the 1994-95 dormant season is not nearly so easy. The fall of 1994 was very mild; temperatures remained above freezing through December (Figure 20). Yet the winter temperatures were not nearly as severe (Figure 21). The 1994 tissue may not have adequately hardened off given the warm and extended fall, and succumbed to freeze injury more readily. Another form of freeze injury can occur during the winter or spring when temperatures rise close to or above freezing then plunge well below freezing again. This occurred in January of 1996 (Figure 19) and in March of 1995 (Figure 21).

Areas that were affected by these factors are at a high risk for a repeat of these injuries. It appeared that jack pine suffered some injury but the severity was lower. If trees must be planted in the affected locations, jack pine may be a better choice than red pine. It may be wiser to abandon the idea of planting trees in areas where freeze injury occurs. Pests such as Sphaeropsis shoot blight and bark beetles could build up in dying tress and these areas could serve as a source of inoculum and breeding material.

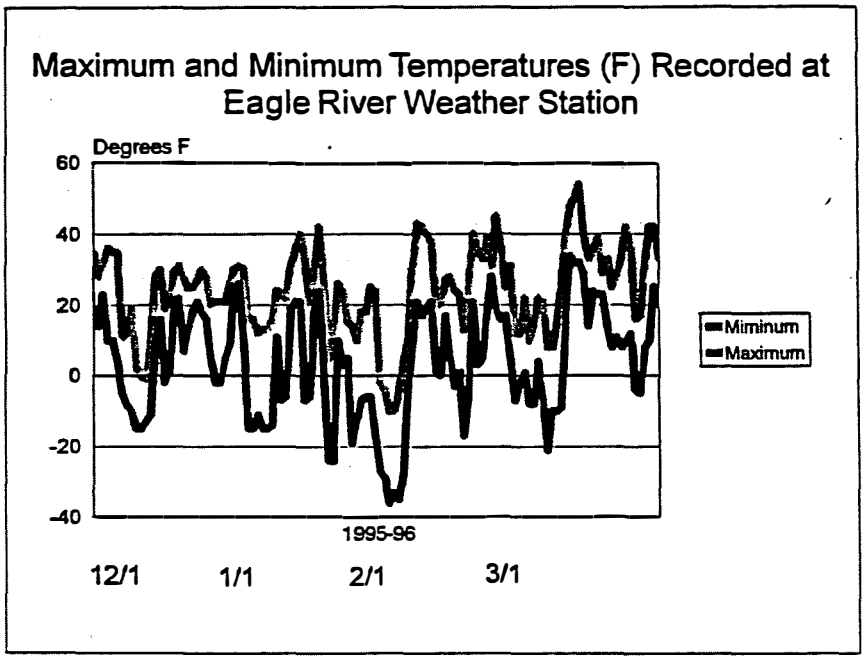

Figure 19. Maximum and minimum temperatures recorded at Eagle River Weather Station, December 1995 through March 1996.

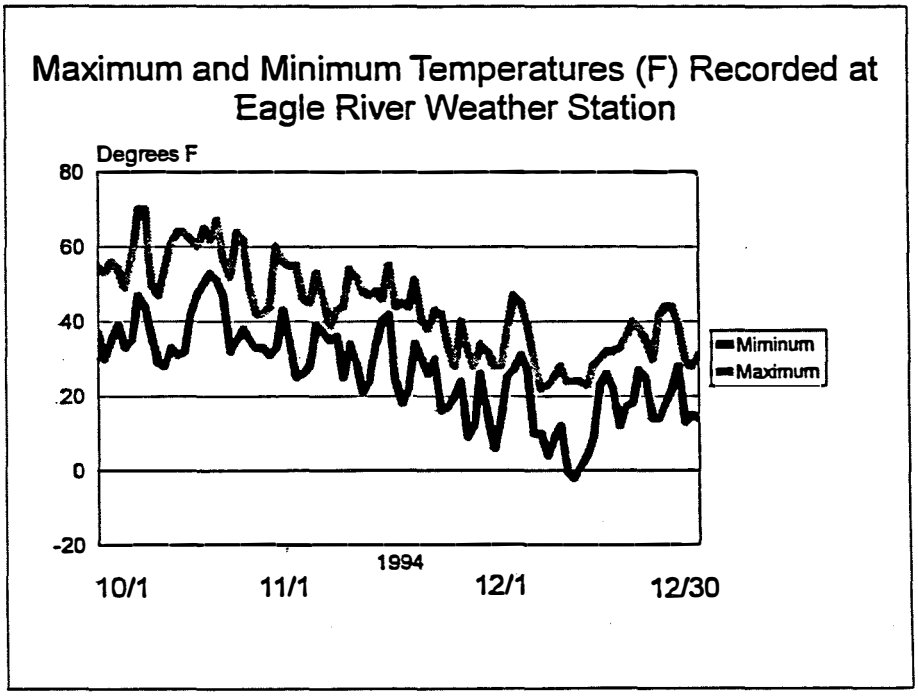

Figure 20. Maximum and minimum temperatures recorded at Eagle River Weather Station, October 1994 through December 1994.

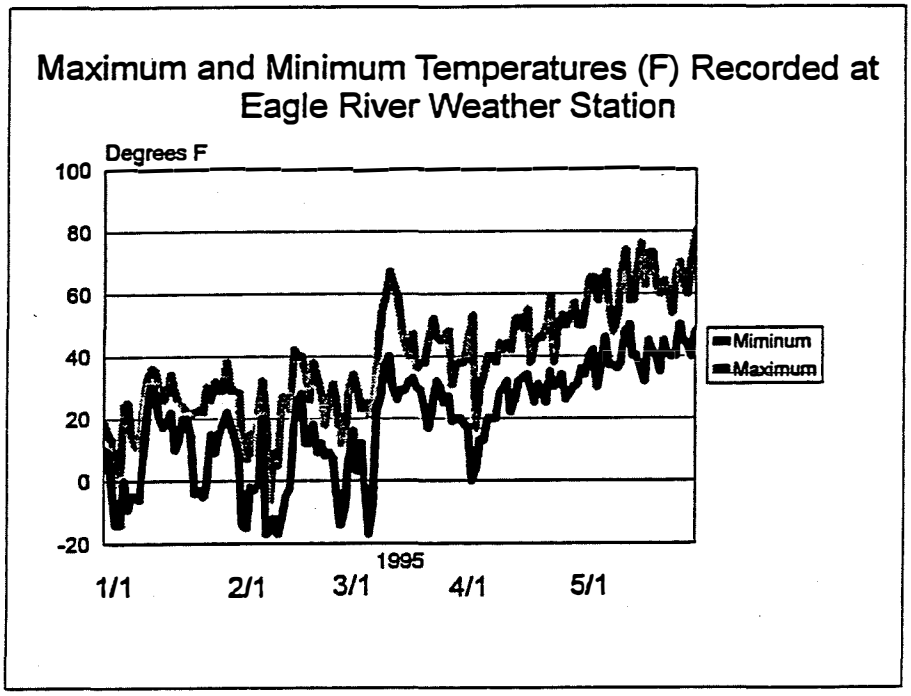

Figure 21. Maximum and minimum temperatures recorded at Eagle River Weather Station, January 1995 through May 1995.